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# SPATIAL AND TEMPORAL VARIABILITY IN ZOOPLANKTON COMMUNITY DYNAMICS IN THREE URBANIZED BAYOUS OF THE PENSACOLA BAY SYSTEM, FLORIDA, USA

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**ABSTRACT** Spatial and temporal patterns in zooplankton community composition and abundance in coastal areas of the Gulf of Mexico are not well understood. Spatial and temporal differences in zooplankton community composition and abundance from 10 stations located in four sites are presented (Pensacola Bay and Bayou Texar, Bayou Chico, and Bayou Grande, three adjacent mesohaline-tidal bayous affected by urban and industrial development). Statistically significant differences ( $P < 0.05$ ) were found in log-biovolume among sites. The mean biovolume of zooplankton was highest in Pensacola Bay ( $0.38 \text{ ml m}^{-3}$ ) followed by Bayou Grande ( $0.21 \text{ ml m}^{-3}$ ), Bayou Chico ( $0.14 \text{ ml m}^{-3}$ ), and Bayou Texar ( $0.06 \text{ ml m}^{-3}$ ). Mean zooplankton abundances (organisms  $\text{m}^{-3}$ ) in Pensacola Bay ( $3,100 \text{ m}^{-3}$ ) and Bayou Grande ( $3,000 \text{ m}^{-3}$ ) were more than double the abundances in Bayou Texar ( $1,400 \text{ m}^{-3}$ ) and Bayou Chico ( $1,100 \text{ m}^{-3}$ ). The calanoid copepod *Acartia tonsa* Dana was the dominant species in the study area. The observed differences in the zooplankton community may be attributable to either one or a combination of factors such as water quality (toxicity), predation, and nutrient availability. Zooplankton abundance increased following two hurricanes that impacted the study area.

## INTRODUCTION

The Gulf of Mexico (Gulf) is a valuable economic and ecological resource that receives contaminants from a variety of sources (USEPA 1994a). These include the effluents from 3,700 permitted outfalls, drainage of 33 rivers, oil/chemical spills, deposition of dredged spoils, and nonpoint runoff from urban and agricultural areas. As a consequence, the ecological condition of the Gulf is thought to be declining as evidenced by decreases in fisheries, wetlands, and seagrasses (USEPA 1994a).

Little information exists on spatial and temporal response of zooplankton to anthropogenic activity in Gulf coastal areas. This is surprising since the meso-zooplankton community ( $> 200 \mu\text{m}$ , Sieburth et al. 1978) is an important biological component of coastal food webs. Copepods are often the major constituents of the meso-zooplankton and an important herbivore in the plankton community (Landry 1977). Due to the density of their fecal pellets, the meso-zooplankton play a critical role in the sinking flux or exportation of primary production to the sediments (McCave 1984, Michaels and Silver 1988). Copepods are important grazers of phytoplankton, particularly during phytoplankton blooms, and they reproduce rapidly when food is abundant (Durbin et al. 1990, White and Roman 1992, Buskey 1993, Dam et al. 1994, Mallin and Pearl 1994, Dagg 1995). In addition, they serve as food for larval fish, both through direct predation (Motta et al. 1995) and the production of eggs and larvae which may provide critically-sized nutritious food for larval fish (Runge 1988).

The sources, causes, extent, and biological consequences of chemical contamination in Gulf coastal rivers, bays, and estuaries are not well understood (USEPA 1994b). Of the research needs that exist for the Gulf, a high priority has been placed on defining spatial and temporal patterns of the community structure of the various biota inhabiting impacted and unimpacted coastal areas. The current study was conducted in three urbanized bayous which are typical of those near populated coastal areas of the Gulf. Previous environmental surveys, during which chemical and biological analyses were performed, have been conducted in these bayous and Pensacola Bay (Jones et al. 1990, Stone and Morgan 1990, NWFM 1997). No published information exists, however, that compares the condition of the zooplankton community between areas of different environmental quality. This research provides information on the seasonal and spatial distribution of the zooplankton and compares that information with what is known about the chemical quality of the water and sediments in these bayous.

In addition to contaminant inputs from anthropogenic sources, areas of the Gulf are impacted by frequent episodic weather events. Understanding the effects of episodic events like hurricanes is important (Wiens and Parker 1995, Boero 1996). The few reported storm-related studies conducted in the Gulf region have examined the effects of storms on biota other than zooplankton (Isphording et al. 1987, Boero 1996, Posey et al. 1996, Rakocinski et al. 2000). A rare opportunity to provide some perspective on the effects of two consecutive hurricanes on zooplankton occurred during this study.

## MATERIALS AND METHODS

### Study area

This one year study was conducted in conjunction with a multi-year fish abundance and diversity study in Pensacola Bay and three adjacent bayous near Pensacola, Florida (Figure 1)(Larry Goodman, personal communication, US EPA, Gulf Breeze, FL). This study was conducted from March 1995 through March 1996. Hurricanes Erin (Category 1) and Opal (Category 4) directly impacted the study area during August and October 1995. Detailed physical and chemical descriptions of the water bodies have been previously reported (Lewis et al. 2001). Three sampling stations each were located in Pensacola Bay and Bayou Grande and two each in Bayou Chico and Bayou Texar. Physical and chemical measurements were taken in-situ at each station during the field collections. Salinity, pH, temperature ( $^{\circ}\text{C}$ ), and dissolved oxygen (DO, mg/L) were measured using a Hydrolab H<sub>2</sub>O Sonde® (Hydrolab, Inc., Austin, TX) at 1 m depth intervals. Salinity was measured using Practical Salinity Units (psu, Unesco 1981).

### Zooplankton collection and analysis

Duplicate zooplankton samples were collected in all months except April, December, and February from each of the 10 sampling stations (only Pensacola Bay was sampled in July). Procedures for collection and analysis of the zooplankton followed the guidelines of Jacobs and Grant (1978), except that zooplankton were collected using a 0.3 m diameter plankton net (0.07 m<sup>2</sup>). The 153  $\mu\text{m}$  mesh net was equipped with a flow meter (General Oceanic, Inc., Miami, FL) and a 2.5 kg weight attached to the bottom of the net ring. The length of the tow line was adjusted each minute during sampling to simulate an oblique tow (actually sampling at five discrete depths over the depth range at each station). Flow meter counts were used to calculate the volume of water sampled. Tow speed was about 1 m s<sup>-1</sup>. Duplicate 5 min tows were conducted in opposite directions at each collection station. The zooplankton samples were preserved with 10% formalin.

The total settled biovolume was recorded for each sample. For most samples, the biovolume was measured using the graduations on 50 ml centrifuge tubes, but a graduated cylinder was used for larger samples. The presence of numerous ctenophores inhibited accurate

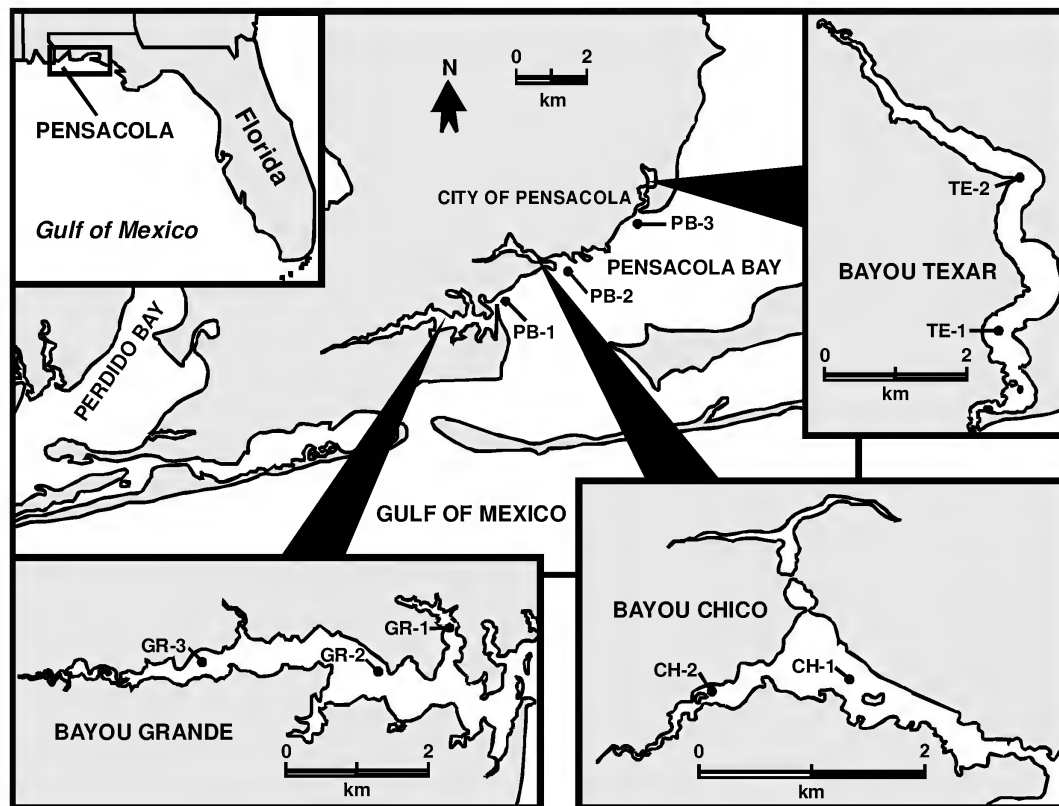


Figure 1. Map of study area showing sampling sites and stations. The four sampling sites are Pensacola Bay (PB), three stations; Bayou Grande (GR), three stations; Bayou Chico (CH), two stations; Bayou Texar (TE), two stations.

determination of the true meso-zooplankton biovolume in about 40 of the 180 samples collected. Consequently, those biovolume measurements were excluded from statistical analysis. In addition to biovolume, 110 samples were selected for taxonomic identification and abundance measurements.

To measure abundance, zooplankton samples were stained with rose-bengal and larger organisms removed ( $>1$  mm). Samples were then diluted with water until a density of about 200–400 organisms  $\text{ml}^{-1}$  was achieved, then the sample was shaken to obtain a homogenous mixture and a 1 ml sub-sample was immediately removed and placed in a counting chamber. A minimum of 200 organisms was counted. In addition to enumeration, the zooplankton were identified to the lowest possible taxon using regional taxonomic keys (e.g., Owre and Foyo 1967, Gosner 1971, Smith 1977). The Shannon-Weiner diversity index (Shannon and Weaver 1949) was also calculated for each sample. This index is the most widely used of its type, and its strengths and weaknesses have been previously described (Washington 1984).

### Statistical Analysis

Samples for taxonomic analysis were not randomly selected; therefore, comparisons of means based on numerical abundances and diversity could be biased. As a result, statistical analyses to determine significant differences among sites were performed on the biovolume data only. Means and standard deviation for abundance and diversity data are provided to allow the reader to visualize spatial and temporal trends. All biovolume and abundance measurements were divided by the volume

( $\text{m}^3$ ) of water sampled. Initial examination of the data suggested that the empirical distributions of biovolume were log-normal. Biovolume data were log-transformed to achieve normality, and correlation, regression, and analysis of covariance (ANCOVA) were conducted on the logarithmic scale. Correlation analysis was used to examine the parametric relationship between log-biovolume and independent variables (i.e., salinity). We then used regression analysis to define further significant correlation between log-biovolume and salinity. Because differences in sites may in part be due to differences in salinity, salinity was treated as a covariate in the ANCOVA to test for differences in log-biovolume among sites. All tests of statistical significance were based on the 95% confidence level ( $P < 0.05$ ).

### RESULTS

The physical and chemical measurements were more variable between sampling periods than they were spatially within a single time period. For example, mean surface salinity (Figure 2) usually differed by  $<10$  psu across stations during sampling periods, but within each station salinity generally differed by  $>10$  psu across all sampling periods. Temperature ranged from a winter minimum of  $10^\circ\text{C}$  to a summer maximum of  $32^\circ\text{C}$ , but differed by  $<2^\circ\text{C}$  across stations during any sampling period. Dissolved oxygen was higher in winter than summer, ranging from  $6.1$ – $11.8$   $\text{mg L}^{-1}$  and pH ranged from  $6.8$ – $8.2$ .

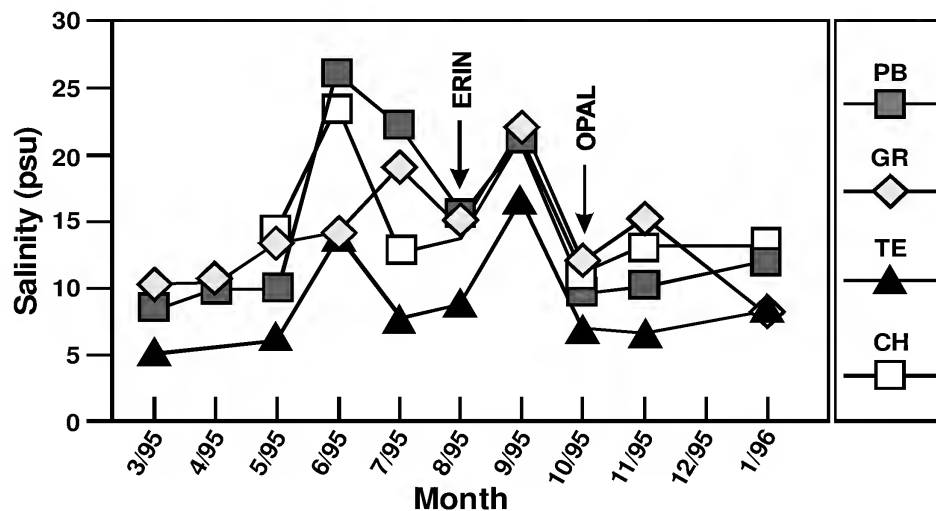


Figure 2. Mean surface salinity at the four study sites Pensacola Bay (PB), Bayou Grande (GR), Bayou Chico (CH), and Bayou Texar (TE) recorded during collection of zooplankton samples. Approximate dates when hurricanes Erin and Opal impacted the study sites are indicated.

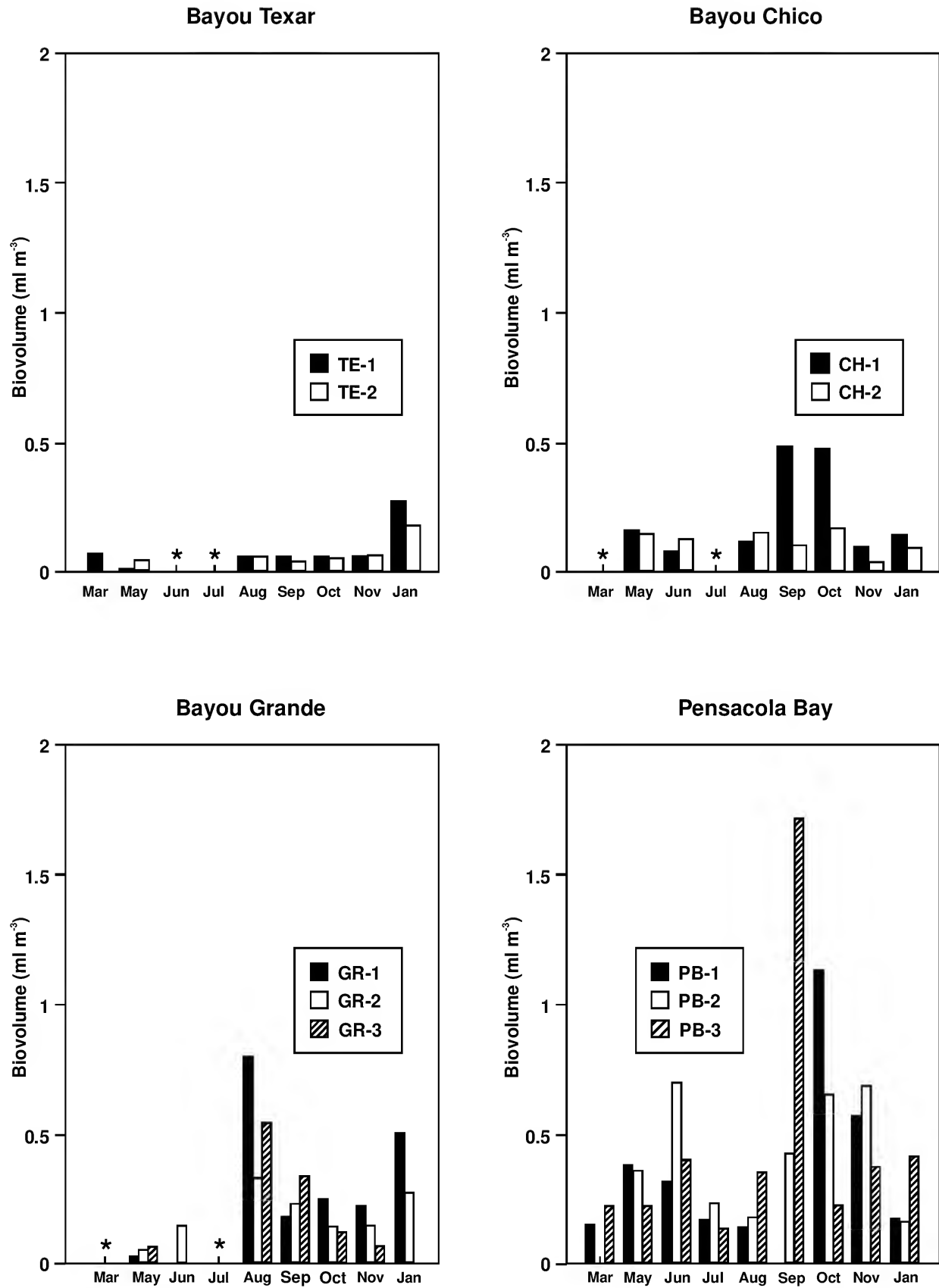


Figure 3. Biovolume ( $\text{ml m}^{-3}$ ) of zooplankton samples collected in 1995–1996 for 10 stations in the four study sites. Legends correspond to stations in Figure 1. Asterisks indicate no data.

### Biovolume

Monthly zooplankton biovolume ( $\text{ml m}^{-3}$ ) for the 10 stations is shown in Figure 3. Peak biovolumes occurred during August at all stations in Bayou Grande, during October in Bayou Chico, and during January in Bayou Texar. In contrast, Pensacola Bay peak biovolumes occurred at different times at different stations. The mean biovolume was  $0.38 \text{ ml m}^{-3}$  ( $\pm 0.31$ ) in Pensacola Bay,  $0.21 \text{ ml m}^{-3}$  ( $\pm 0.25$ ) in Bayou Grande,  $0.14 \text{ ml m}^{-3}$  ( $\pm 0.11$ ) in Bayou Chico, and  $0.06 \text{ ml m}^{-3}$  ( $\pm 0.06$ ) in Bayou Texar. Using data from all months, log-biovolume was moderately correlated with surface salinity ( $r = 0.41$ ,  $P < 0.0001$ ). An ANCOVA with salinity as covariate indicated that log-biovolume was significantly different among sites (ANCOVA,  $R^2 = 0.49$ ;  $P < 0.0001$ ). Duncan's Multiple Range Test, conducted on the adjusted means, indicated that the mean log-biovolume was highest in Pensacola Bay and lowest in Bayou Texar. The means in Bayou Grande and Bayou Chico were not significantly different from one another but were significantly lower than that of Pensacola Bay and higher than that of Bayou Texar. The ranks of the adjusted and unadjusted means were the same, indicating that the effects of salinity were the same within each of the sites.

### Abundance

The relative abundance of zooplankton taxa is summarized in Figure 4. Where overall abundances of individual taxa were low, they were combined into groups (i.e., other calanoida, total branchiopoda). The mean abundance (organisms  $\text{ml}^{-1}$ ) was highest in Pensacola Bay at  $3,100 \text{ m}^{-3}$  ( $\pm 2500$ ) compared to  $3,000 \text{ m}^{-3}$  ( $\pm 3100$ ) in Bayou Grande,  $1,400 \text{ m}^{-3}$  ( $\pm 1800$ ) in Bayou Texar, and  $1,100 \text{ m}^{-3}$  ( $\pm 1600$ ) in Bayou Chico. The peak numerical abundance values for each bayou in decreasing order were:  $12,500 \text{ m}^{-3}$  for Bayou Grande (January);  $11,600 \text{ m}^{-3}$  for Pensacola Bay (October);  $6,100 \text{ m}^{-3}$  for Bayou Chico (October); and  $5,700 \text{ m}^{-3}$  in Bayou Texar (January).

### Community Composition

Overall, 80 taxa were identified in this study; 20 were identified to species and 17 to genera. The 10 most abundant taxa for each of the bayous and Pensacola Bay appear in Table 1. See Appendix for a complete taxonomic list of organisms found in this study. Zooplankton community composition in Pensacola Bay and the bayous was similar. The zooplankton in the bayous was dominated by copepods and crustacean nauplii (Figure 4); the copepod *Acartia tonsa* Dana, 1852 was the dominant taxa in most samples. However, in Pensacola Bay a

cyclopoid copepod (*Oithona* sp.) was dominant during July and August at several stations and a branchiopod (*Podon* sp.) dominated most bay samples in May.

The mean diversity index for the 10 stations ranged from 0.79–1.19 (Table 2). The values were greatest in Pensacola Bay and seasonal variation was evident with the highest diversity occurring in May (1.60) and July (1.99). The diversity index peaked in Bayou Grande in September (1.18) and October (1.75) and in Bayou Texar during August (1.59) and September (1.82). Diversity was low during November in Pensacola Bay, Bayou Grande, and Bayou Texar. In Bayou Chico, the diversity peaked in June (1.41, 1.74) and January (1.44, 1.49). Species diversity was lowest during March in Bayou Chico but also low during September for one station.

Two hurricanes directly impacted the study area within a three-month period, and salinity was affected dramatically. The salinity range decreased from 20–24 psu in July (pre-hurricane) to 14–17 psu in late August (post-hurricane) in the top 2 m of the water column in Pensacola Bay almost a month after the first hurricane (Erin). Bottom water salinity (>2 m depth) was similar to pre-hurricane conditions. After hurricane Opal (October 3), hydrographic measurements were made on October 12. Salinity decreased to <6 psu in the top 3 m of Pensacola Bay and at one station, PB-2; the salinity at 4 m dropped from 32 psu in July to 6 psu (post hurricane). The reduction in salinity was less in the bayous than in Pensacola Bay, especially at depths greater than 1 m. Since there is no comparable data from the same periods without hurricanes, meaningful statistical analyses cannot be conducted. However, zooplankton biovolume and abundance in Pensacola Bay increased for 1–2 months following each hurricane. Similar effects in the bayous were less obvious.

### DISCUSSION

The most significant finding in this study is the spatial difference in biovolume of zooplankton. Overall, mean biovolume was significantly greater in Pensacola Bay as compared to the bayous, especially as compared to Bayou Texar ( $P < 0.05$ ). Bayou Texar had significantly lower biovolume than all other sites, but Bayou Chico and Bayou Grande were not significantly different. The zooplankton community can be impacted by multiple and interacting physical, chemical, and biological factors. Surface salinity, DO, pH, and temperature were not dramatically different among sites in the study area during the individual sampling periods. None of these parameters were, thus, likely to cause the biovolume

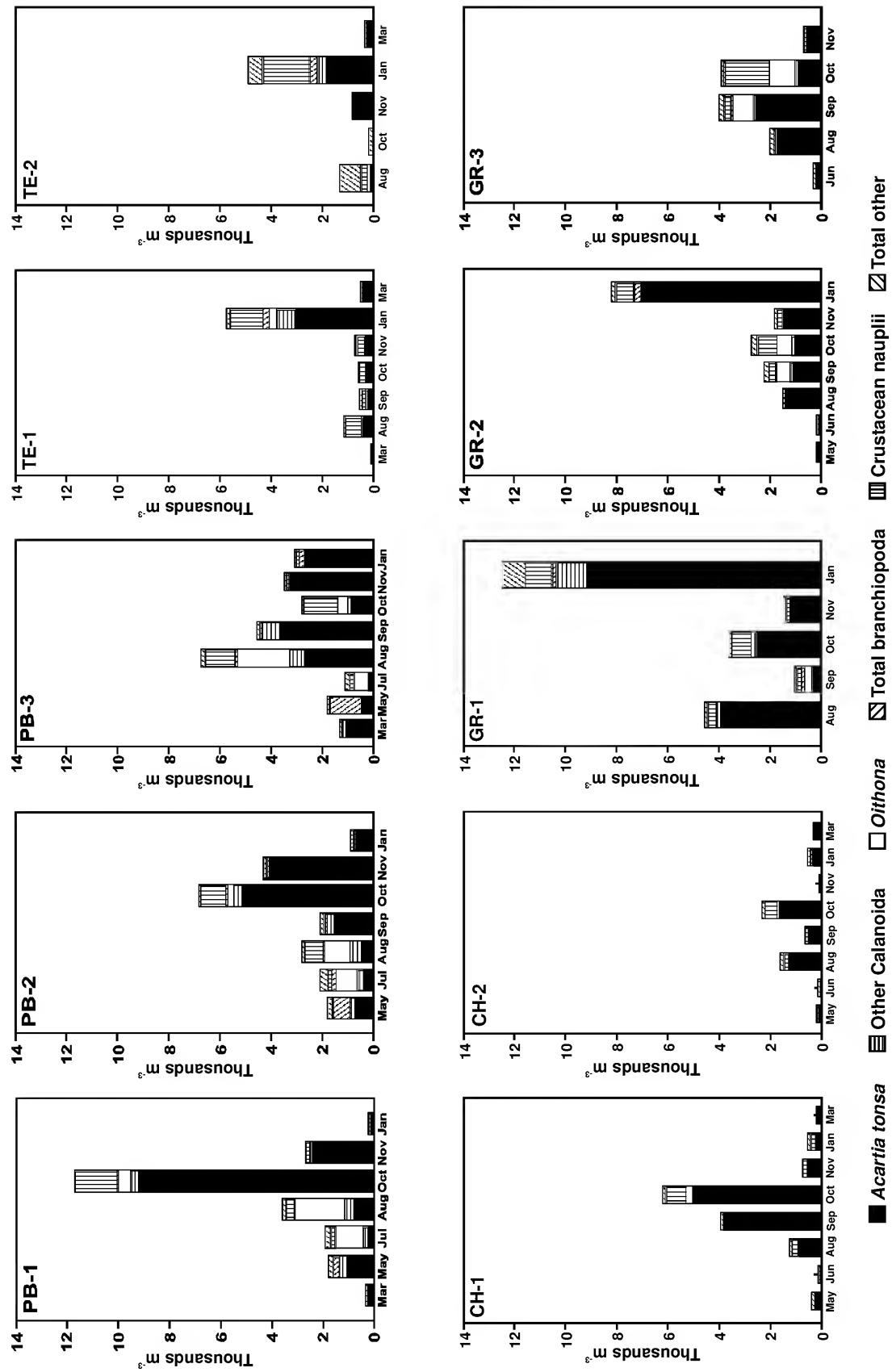


Figure 4. Relative abundance (thousands  $m^{-3}$ ) of major components from selected zooplankton samples collected in 1995–1996 at the 10 stations in this study. Legends correspond to stations shown in Figure 1.



TABLE 1

Ten dominant taxa from each of the four study sites. LPIL = lowest possible identification level.

Pensacola Bay	Bayou Grande	Bayou Texar	Bayou Chico
<i>Acartia tonsa</i>	<i>Acartia tonsa</i>	<i>Acartia tonsa</i>	<i>Acartia tonsa</i>
<i>Oithona</i> (LPIL)	<i>Oithona</i> (LPIL)	<i>Oithona</i> (LPIL)	<i>Oithona</i> (LPIL)
<i>Podon</i> (LPIL)	<i>Balanus</i> (LPIL)	<i>Podon</i> (LPIL)	<i>Balanus</i> (LPIL)
<i>Labidocera aestiva</i>	<i>Podon</i> (LPIL)	<i>Labidocera aestiva</i>	<i>Rhithropanopeus harrisii</i>
<i>Oikopleura</i> (LPIL)	<i>Evadne</i> (LPIL)	<i>Evadne</i> (LPIL)	<i>Podon</i> (LPIL)
<i>Evadne</i> (LPIL)	<i>Oikopleura</i> (LPIL)	<i>Oikopleura</i> (LPIL)	<i>Polydora</i> (LPIL)
<i>Balanus</i> (LPIL)	<i>Polydora</i> (LPIL)	<i>Balanus</i> (LPIL)	<i>Evadne</i> (LPIL)
<i>Lucifer faxoni</i>	<i>Rhithropanopeus harrisii</i>	<i>Lucifer faxoni</i>	<i>Sagitta</i> (Includes LPIL and <i>S. friderici</i> )
<i>Sagitta</i> (Includes LPIL and <i>S. friderici</i> )	<i>Lucifer faxoni</i>	<i>Sagitta</i> (Includes LPIL and <i>S. friderici</i> )	<i>Oikopleura</i> (LPIL)
<i>Penilia</i> (LPIL)	<i>Labidocera aestiva</i>	<i>Penilia</i> (LPIL)	<i>Eurypanopeus depressus</i>

differences among sites. However, because salinity was moderately correlated with log-biovolume ( $P < 0.05$ ,  $r = 0.41$ ), the differences in log-biovolume among sites were tested using ANCOVA with salinity as the covariate. The results indicated that sites accounted for 48% of the variability when salinity effects were taken into consideration. We speculate that various combinations of factors, such as predation, toxicity, and food web dynamics are affecting this community.

Differences in water and sediment quality between sites may account for differences in zooplankton biovolume, since zooplankton biovolume and abundance were lowest in the two bayous which are impacted most by anthropogenic activity in their watersheds. Both Bayou Texar and Bayou Chico are considered to be eutrophic, experience seasonal hypoxia, and have degraded water and sediment quality (Collard 1991, Lewis et al. 1999). Copper concentrations in these waters exceeded Florida water quality criteria (2.9  $\mu\text{g/L}$ ) continuously during a two-year study while other metals intermittently exceeded the criteria (Lewis et al. 1999). Furthermore, 15 compounds in the sediments exceeded proposed sediment quality assessment guidelines, indicating a high level of degradation and risk to biota. Copper is highly toxic to copepods and can cause reproductive effects at concentrations as low as 1–5  $\mu\text{g/L}$  (Beers et al. 1977, Reeve et al. 1977, Sosnowski and Gentile 1978, Sunda et al. 1990). Studies determining the in-situ toxicity of the bayou waters would provide needed insight on this issue.

In addition to water quality, a trophic cascade effect (Carpenter et al. 1985) may explain the lower densities in the bayous through increased predation on zooplankton.

There is some evidence that fish densities are higher in the bayous than in Pensacola Bay (Larry Goodman, personal communication). Other predators such as ctenophores may also be important and were more common in the bayous than in Pensacola Bay. However, Bayou Grande had more ctenophores than the other two bayous where zooplankton abundance was lower. Consequently, the role of predation by ctenophores or fish and its significance in explaining our observations is uncertain and needs further study.

Other studies describing the zooplankton community in the study area were not available in the scientific literature. However, data were available for areas adjacent to Pensacola Bay. Zooplankton abundances in Escambia and East Bay, Florida, reported by Olinger (1975) showed mean values of 36,674  $\text{m}^{-3}$  in Escambia Bay and 32,253  $\text{m}^{-3}$  in East Bay (a 74  $\mu\text{m}$  mesh net was used in that study and would be expected to result in higher abundance values). Using a 154  $\mu\text{m}$  mesh net, Hopkins (1966) reported 40,100  $\text{m}^{-3}$  as the annual mean in St. Andrew Bay, Florida, and Buskey (1993) reported a mean of 6,100  $\text{m}^{-3}$  in Nueces Estuary, Texas. These values were considerably greater than the mean abundance reported here for Pensacola Bay (3,059  $\text{m}^{-3}$ ). In contrast, McIlwain (1968) reported a mean copepod density in Mississippi Sound of 115 copepods  $\text{m}^{-3}$  which is much lower than the copepod densities reported here where the abundance of *Acartia* alone frequently exceeded 1,000  $\text{m}^{-3}$ . Peak zooplankton densities of 11,600  $\text{m}^{-3}$  reported for Pensacola Bay and 12,500  $\text{m}^{-3}$  for Bayou Grande were also lower than those found in St. Andrew Bay (97,471  $\text{m}^{-3}$ , Hopkins 1966) and Nueces

TABLE 2

**Zooplankton diversity (Shannon-Weiner) in 10 stations sampled during 1995–1996. Values in parentheses are SD ( $n = 2$ ). See Figure 1 for station identification.**

Month	Stations									
	PB1	PB2	PB3	GR1	GR2	GR3	CH1	CH2	TE1	TE2
Mar 95	1.02 (0.36)		0.70 (0.07)						0.74 (0.19)	
May 95	1.60 (0.32)	1.57 (0.00)	0.96 (0.05)		1.06	0.98 (0.09)	1.08 (0.06)	1.64 (0.09)		
Jun 95					1.05		1.41 (0.15)	1.74		
Jul 95	1.46 (0.04)	1.99 (0.15)	1.76 (0.13)							
Aug 95	1.32 (0.1)	1.60 (0.15)	1.50 (0.09)	0.66 (0.30)	0.45 (0.00)	0.65 (0.17)	0.85 (0.02)	0.69 (0.09)	1.23	1.59
Sep 95		1.07	0.75	1.75	1.41	1.13	0.17	0.69	1.82	
Oct 95	0.69 (0.13)	0.86 (0.05)	1.15	0.78 (0.08)	1.26 (0.01)	1.18 (0.03)	0.64 (0.05)	0.86 (0.12)	1.07 (0.03)	1.45
Nov 95	0.42	0.51 (0.15)	0.40 (0.07)	0.55	0.60	0.49	.61	1.17	1.01	0.13
Jan 96	1.16 (0.08)	0.92 (0.14)		0.91 (0.19)	0.63		1.44 (0.03)	1.49 (0.09)	1.45 (0.00)	1.06 (0.01)
Mar 96							0.14 (0.01)	0.13 (0.05)	0.83 (0.18)	0.45 (0.05)
Station Mean	1.10	1.19	1.00	0.93	0.92	0.89	0.79	1.05	1.16	0.94
Bay Bayou Mean			1.09			0.91		0.92		1.05

Bay and Corpus Christi Bay (40,000 m<sup>-3</sup>, Buskey 1993). Causes of the lower zooplankton density observed in Pensacola Bay relative to values reported for other Gulf estuaries are unknown; however, one possibility is that in summer Escambia/Pensacola Bay phytoplankton is dominated by cyanobacteria which produce food too small to support most meso-zooplankton organisms (Lores et al. 2001).

In this study, 20 organisms were identified to species and an additional 17 to genera. Overall, there were more than 80 taxa identified. Hopkins (1966) reported a total of 37 organisms identified to species in Tampa Bay and a range of 16–37 identified in samples from St. Andrew Bay. Dye (1987) reported 54 taxa (identified to at least the genus level) in Escambia Bay and 49 in East Bay, with a peak taxa richness in October in Escambia Bay and in December for East Bay. The minimum richness for Escambia and East Bay occurred in March and June. In contrast, the highest diversity values in Pensacola

Bay occurred in early summer and the lowest in fall. A similar pattern was reported by Hopkins (1966) for St. Andrew Bay, with higher diversity in summer and lower diversity in winter. However, the diversity patterns seen in the bayous seem to correspond more closely to the patterns seen by Dye (1987) in Escambia and East Bays. Diversity values in the bayous (Table 2) were often high in the summer and early fall (0.45–2.0 from June–September) and low in early spring (0.13–1.0 during March). Two bayous did have a sharp drop in diversity at one site during the fall (Bayou Chico in September and Bayou Texar in November) that may have been related to seasonal DO problems or possibly delayed effects from the hurricanes. Hopkins (1966) reported a trend toward higher diversity (types of plankton) with increasing salinity and a similar trend was seen in this study.

*Acartia tonsa* was the most abundant species in this study, as in several other studies in Gulf estuaries (Gillespie 1971, Dye 1987, Buskey 1995). McIlwain

(1968) reported *A. tonsa* as the overall dominant species, but found *Labidocera aestiva* Wheeler, 1901, *Labidocera* sp., *Paracalanus parvus* (Claus, 1863), *Euterpina acutifrons* (Dana, 1848), and *Temora longicornis* (Müller, 1792) to be dominant at times. However, Hopkins (1977) found *Oithona colcarva* Bowman, 1975 to be dominant in most samples from Tampa Bay with *A. tonsa* the dominant during winter. In St. Andrew Bay, Hopkins (1966) found high variability in dominants at the station nearest the Gulf, while *Oithona simplex* Farran, 1913 or *Centropages hamatus* (Lilljeborg, 1853) dominated the middle stations and East Bay and *A. tonsa*, *Parvocalanus crassirostris* (Dahl, 1894) and *Pseudodiaptomus coronatus* Williams, 1906 were dominant in the upper reaches of West Bay.

Mallin and Pearl (1994) reported a positive correlation between river flow, phytoplankton growth, and zooplankton grazing. Hurricanes certainly increased river flow and appeared to increase biovolume and abundance in Pensacola Bay during the period following the hurricanes from September–November. This trend of stimulating zooplankton production may have been due to the increase in freshwater supply and the associated allochthonous inputs.

In summary, the results reported here indicate that the abundance of zooplankton in Pensacola Bay and associated bayous was low relative to historical data from other estuaries within the Gulf. Considerable spatial and temporal variations in zooplankton community structure were evident in this study, indicating that data generalizations and extrapolations should be made with caution when applied to characterizing this biota in coastal areas. A variety of chemical and biological factors, such as water quality, and to a lesser extent, predation pressure may have been the cause of the observed differences. Two hurricanes impacted the study area causing a short-term decrease in salinity with a concomitant increase in zooplankton. The zooplankton community is an important component of estuarine ecosystems and trophic disruptions in this community due to imbalanced predation, toxicity, or unsuitable environmental parameters may have significant effects on the function of these ecosystems.

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APPENDIX

Taxonomic list for Pensacola Bay-Bayou Study

Cnidaria

Hydrozoa

Hydroida

Bougainvillidae

*Nemopsis bachei* Agassiz, 1862

Scyphozoa

Semaeostomae

Pelagiidae

*Chrysaora quinquecirrha* (Desor, 1848)

Ulmaridae

*Aurelia* sp.

Siphonophora

Diphyidae

*Lensia* sp.

Rotifera

Annelida,

Oligocheta

Polychaeta

Spionidae

*Polydora* sp.

Syllidae

Arthropoda

Crustacean nauplii

Crustacea

Branchiopoda

Diplostraca

Polypheniidae

*Evadne* sp.

Cladocara

(cladoderan)

Podon

Sididae

*Penilia* sp.

Branchuria

Argulidae

*Argulus* sp.

Cirripedia

Thoracica

Balanidae

*Balanus* sp.

Copepoda

Calanoida

Acartiidae

*Acartia tonsa* Dana, 1852

Eucalanidae

*Eucalanus monachus* Giesbrecht, 1892

Centropagidae

*Centropages* sp.

*Centropages furcatus* Brady, 1883

Pontellidae

*Labidocera aestiva* Wheeler, 1901

Caligoida

Cyclopoida

Clausidiidae

*Saphirella* sp.

Corycaedidae

*Corycaeus* sp.

*Corycaeus catus* F. Dahl, 1894

*Corycaeus clausi* F. Dahl, 1894

*Corycaeus limbatus* Brady, 1883

*Corycaeus speciosus* Dana, 1852

Cyclopodidae

Oithonidae

*Oithona* sp.

Oncaeidae

*Oncaea venusta* Philippi, 1843

Harpacticoida

Malacostraca

Cumacea

Decapoda

Dentrobranchiata

Luciferidae

*Lucifer faxoni* Borradaile, 1915

Palaemonidae

*Palaemonetes* sp.

Sergestidae

*Acetes americanus carolinae* Hansen, 1933

Pleocyemata

Anomura

Callianassidae

Unid. Callianassidae

Diogeneiidae

*Clibanarius vittatus* (Bosc, 1802)

Porcellanidae

*Eucramus praelongus* Stimpson, 1860

Brachyura

Grapsidae

*Sesarma* sp.

*Armases cinereum* (Bosc, 1802)

Portunidae

*Callinectes sapidus* Rathbun, 1896

Xanthidae

*Eurypanopeus depressus* (Smith, 1869)

*Rithropanopeus harrisi* (Gould, 1841)

Ostracoda

Podocopa

Cypridinidae

*Cypridina* sp.

Insecta

Diptera

Chironomidae

*Dicortendipes* sp.

*Polypedilum* sp.

Chaetognatha

Sagittoidea

Aphragmophora

Sagittidae

*Sagitta* sp.

*Sagitta friderici* Ritter-Zahony, 1911

Chordata

Larvacea

Oikopleuidae

*Oikopleura* sp.

Mollusca

Gastropoda

Plecypoda

Platyhelminthes

Turbellaria

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Hydrobiid Snails (Mollusca: Gastropoda: Rissooidea) from St. Andrew Bay, Florida

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## HYDROBIID SNAILS (MOLLUSCA: GASTROPODA: RISSOOIDEA) FROM ST. ANDREW BAY, FLORIDA

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**ABSTRACT** *Heleobops* sp. of Hershler and Thompson appears to be the only previously published record for the gastropod family Hydrobiidae Troschel in tidal waters of the St. Andrew Bay System, Florida. Six species occurred in bayous, marshes, and brackish ponds associated with the System during studies conducted between 1984 and 1999: *Texadina barretti* (Morrison), *Texadina sphinctostoma* Abbott and Ladd, *Littoridinops monroensis* (Frauenfeld), *Littoridinops palustris* Thompson, *Onobops jacksoni* (Bartsch), and *Heleobops* sp. A. The last is an apparently undescribed species closely related to *Heleobops carrikeri* Davis and McKee. Based in part on this study, *Heleobops* sp. A, which occurs in brackish habitats from the System westward to the Chandeleur Islands, is considered conspecific with *Heleobops* sp. of Hershler and Thompson (1992) as well as *Heleobops* sp. Forms B and C of Heard (1992). There are two ecophenotypic shell types of *Heleobops* sp. A, a grayish-brown, smooth-shelled, intertidal variant and a tannish, light-orange, striate, subtidal form, which represent Forms B and C of Heard, respectively. In addition to constituting new records, the occurrence of *T. barretti* and *T. sphinctostoma* in the St. Andrew Bay System represents eastern range extensions for both species. Although their ranges encompass northwestern Florida, *L. palustris* and *L. monroensis* are reported from the System for the first time. The relatively large egg capsules of *Heleobops* sp. A, *L. palustris*, and *L. monroensis* each contain a single ovum, and, depending on temperature, generally require 9 to 14 days before hatching as juveniles. The egg capsules of *T. barretti*, *T. sphinctostoma*, and *O. jacksoni* also contain a single ovum per capsule, but their capsules are distinctly smaller, and, when maintained at room temperature for 5 to 8 days, eggs hatch into free-swimming, shelled-veligers. The distributions of other brackish water hydrobiids known from Florida and the Gulf of Mexico are briefly reviewed.

### INTRODUCTION

In his monograph on the hydrobiid snails of the Florida peninsula, Thompson (1968) reported six species, three of which were new, in brackish water habitats (Table 1). The brackish hydrobiids of Florida are all relatively small species, having a shell with a length rarely exceeding 6 mm. Since Thompson's (1968) pioneering work, three additional brackish species, *Floridiscrobs dysbatus* (Pilsbry and McGinty, 1949), *Spurwinkia minuta* (Pilsbry, 1905), and *Texadina sphinctostoma* Abbott and Ladd, 1951 have been listed from Florida brackish and marine habitats (Cooley 1978, Lyons 1998).

Although hydrobiid snails are often common in Florida's brackish bays and tidal marshes (Thompson 1968), there is only a single published record of a hydrobiid, *Heleobops* sp. from the tidal waters of the St. Andrew Bay System in the Florida Panhandle. That record occurred in the monograph on the hydrobiid subfamily Cochliopinae Tyron, 1866 by Hershler and Thompson (1992).

As part of an extensive investigation of the brackish water mollusks and their digenean parasites, we collected six species of hydrobiids from the environs of St. Andrew Bay. Our study presents new distribution records

with observations on the biology and ecology of these snails.

### MATERIALS AND METHODS

#### Study Area

The St. Andrew Bay System is located on the northern coast of the Gulf of Mexico, referred to here as "Gulf." Figure 1 illustrates station locations. The St. Andrew Bay system is a high salinity estuary with four major basins: St. Andrew Bay, North Bay, West Bay, and East Bay. Geologically, the system is a drowned river channel with many brackish water bayous formed along the local watershed from ancient tributaries (Schmidt and Clark 1980, Taylor 1991).

#### Collection Sites

**Mill Bayou.** Collections were made at two stations located on Mill Bayou. Station 1, located immediately south of the bridge on FL Hwy 390 (30°13.9'N, 85°35.9'W), consisted of a muddy creek bottom, intertidal mud flats, and associated needle rush (*Juncus roemerianus*) with under-story carpets of the plants *Lilaeopsis chinensis* and *Eleocharis parvula*. Depths ranged from 0 to 2 m. During all of our visits, the callianassid ghost shrimp *Lepidophthalmus louisianensis*

TABLE 1

Nominal species (and forms) of extant brackish water hydrobiids known or reported from Florida coastal areas (in Florida, *Probythinella protera* is known only from a fossil record near Tampa). \*1 = Thompson (1968), 2 = Heard (1982), 3 = Hershler and Thompson (1992), 4 = Lyons (1998), 5 = present report, 6 = Heard, Hershler, Thompson (personal observations).

Taxa	Florida coastal distribution	References*
<i>Floridiscrobs</i> Pilsbry and McGinty, 1949		
<i>F. dysbatus</i> (Pilsbry and McGinty, 1949)	SW (high salinity)	4
<i>Heleobops</i> Thompson, 1968		
<i>H. docima</i> Thompson, 1968	Peninsular	1, 3
<i>Heleobops</i> sp. A	NW	5
<i>Heleobops</i> sp. Form A	NW(E. of Apalachicola R.)	2
<i>Heleobops</i> sp. Form B	NW (W. of Apalachicola R.)	2
<i>Littoridinops</i> Pilsbry, 1952		
<i>L. monroensis</i> (Frauenfeld, 1863)	Entire	1, 2, 5
<i>L. palustris</i> Thompson, 1968	Gulf	1, 3, 5
<i>L. tenuipes</i> Couper in Haldeman, 1844	NE	1, 3
<i>Onobops</i> Thompson, 1968		
<i>O. crassus</i> Thompson, 1968	SW	1, 3
<i>O. jacksoni</i> (Bartsch, 1953)	Entire	1, 3
<i>Pyrgophorus</i> Ancey, 1888		
<i>P. platyrachis</i> Thompson, 1968	SE, Gulf	1, 3
<i>Spurwinkia</i> Davis, Mazurkiewicz, and Mandracchia, 1982		
<i>S. salsa</i> (Pilsbry, 1905)	NE	4, 6

(Schmitt, 1935) and the barnacle *Balanus subalbidus* Henry, 1973 (on bridge pilings and submerged wood) were common at this site. The second site, Mill Bayou Station 1A, is located at the east end of Suwanee Street on the western margin of the bayou (30°15.2'N, 85°36.7'W), less than 100 m south of the bayou mouth. This site is characterized by muddy sand and had depths to 2 m. Burrow openings of *L. louisianensis* were a prominent feature of the sediment at this site. Mill Bayou opens into the upper part of North Bay, just below Deer Point Reservoir Dam.

**Upper Goose Bayou.** Station 2 (30°13.9'N, 85°40.1'W), located in the upper reaches of Upper Goose Bayou, is an artificially altered bayou which empties into North Bay about 5 km west of Station 1. The study area was an oval-shaped section of marsh located between marginal pine bluffs and separated by a causeway on the bayou side, with culvert openings connecting it with the primary area termed "Upper Goose Bayou." The collection site was located near the center of the study area along a tidal creek adjacent to a bluff through which a storm-water drainage pipe was buried. The marsh was predominantly characterized by needle rush and drained by several shallow creeks. Smooth cord grass (*Spartina*

*alterniflora*), widgeon grass (*Ruppia maritima*), and other vascular plants occurred along the creek margins. Sediments consisted of an anaerobic, black, silty mud, with a hydrogen sulfide odor.

**Mill Point Marsh.** Station 3 (30°15.8'N, 85°35.7'W) is located about 200 m north of Bailey Bridge at Mill Point in North Bay along FL Hwy 77. It consisted of a short drainage canal that flowed through a larger creek directed south to Mill Point. Station 3 was identified as the subtidal and intertidal areas at the source of the canal. At the collection site, the water depth varied from intertidal to 0.5 m. The area was vegetated predominantly by widgeon grass and needle rush, with the higher areas of the marsh floor covered by a sparse carpet of *L. chinensis* and *E. parvula*. Station 3A was designated as the supratidal area of the higher marsh. Needle rush constituted the primary vegetation at this site, but, as elevation increased, it was replaced by non-marine grasses.

**Maggie Bayou.** Station 4 (30°15.0'N, 85°39.2'W) is located near the head of Maggie Bayou, a small inlet located 0.5 km east of Haven Point and 1.0 km west of Bailey Bridge on North Bay. The collection site was adjacent to and 25 m downstream from a culvert located at the intersection of Tennessee Avenue and 5th Street in



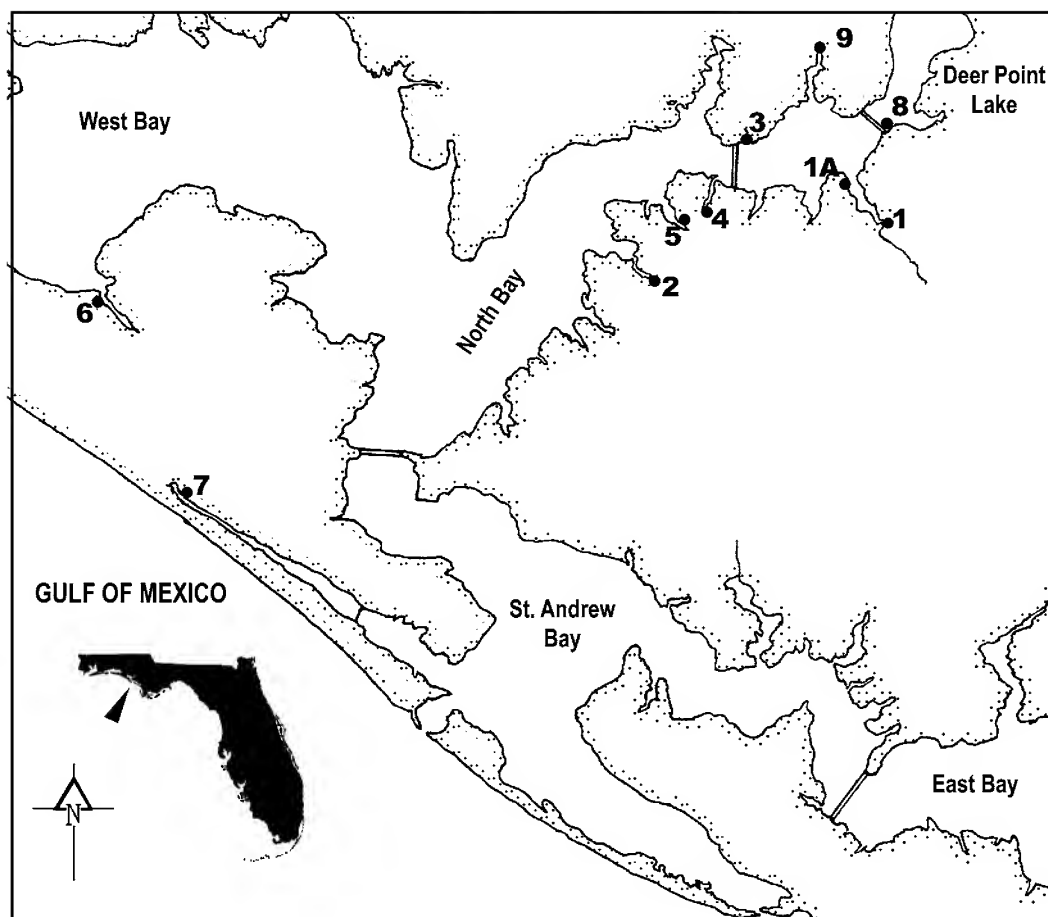


Figure 1. Sampling locations in the St. Andrew Bay System, Florida, 1989–1999. 1. Mill Bayou. 1A. Mill Bayou, 2nd collection site. 2. Upper Goose Bayou. 3. Mill Point Marsh. 4. Maggie Bayou. 5. Lynn Haven Bayou. 6. West Bay Marsh. 7. Grand Lagoon Pond. 8. Deer Point Dam Reservoir. 9. Gainer Bayou.

Lynn Haven. The elevation difference associated with the culvert and the street created a distinct change in the vegetation between the collection site and the area upstream of the culvert under 5th Street. South of the street, cattail (*Typha angustifolia*) dominated. Downstream from the culvert, the creek flowed across a shallow bed of muddy sand that was fringed with a mixture of needle rush and *Cladium jamaicense*. Upgrade from the marsh, a band of *Spartina patens* occurred. The entire station occupied no more than 400 m<sup>2</sup>.

**Lynn Haven Bayou.** Station 5 (30°14.5'N, 85°39.7'W) is located at the northern terminus of New Hampshire Avenue in Lynn Haven at Lynn Haven Bayou. Station 5 was a mud-silt area of the bayou at the street terminus. It is a mesohaline area with a depth range from intertidal to 0.5 m. The bayou margins were fringed primarily with needle rush and smooth cord grass. Station 5A was a drainage ditch that flowed north to the bayou along the street. During our observations, a natural weir had blocked the ditch. Flooding on very high

tides was observed to affect the salinity at the lower end of the ditch, and heavy rainfall abruptly lowered the salinity of the bayou, especially during low tide.

**West Bay Marsh.** Station 6 (30°13.5'N, 85°40.3'W) was associated with a broad expanse of needle rush fringing the shore of Bothertation Bayou, a creek which flowed into West Bay along its southern shore. The creek drained a large area of pine flat woods. It formed a broad intertidal delta vegetated with needle rush and smooth cord grass.

**Grand Lagoon Pond.** Station 7 was an oligohaline pond of about 2 ha and formed the headwaters of Grand Lagoon, a narrow arm of St. Andrew Bay that lay shoreward and parallel to a barrier peninsula (30°10.3'N, 85°47.7'W). The pond lay between FL Hwy 30B and Joan Avenue, adjacent to a trailer park on Panama City Beach. Runoff from the park and a nearby golf course appeared to contribute to the nutrification of the pond. At the source of the pond, the marginal vegetation consisted of dense growths of cattail and green taro (*Colocasia*

*esculentum*). The eastern end of the pond, where collections were made, was drained by a short creek run, which formed a brackish tidal marsh (needle rush). During our observations, the pond experienced episodes of elevated salinity associated with high, wind-blown tides, especially during summer months. Water-hyssop (*Bacopa monnieri*) extended in dense floating mats from the shore into part of the pond and creek run. The water depth in this area of the pond and in the small creek connecting it to Grand Lagoon was less than 1 m in depth. During Hurricane Georges (26 September 1998) the water depth of the pond was temporarily elevated by 0.5 m, and its water was fresh (0‰) for over a week.

**Deer Point Dam Reservoir.** Station 8 is located at the public boat ramp on FL Hwy 2321, 4.5 km north of US Hwy 231 and adjacent to Deer Point Dam in Bay County, Florida (30°15.8'N, 85°36.2'W). The lake is a man-made, freshwater reservoir of 2000 ha created in 1961 by the damming of the northeastern arm of North Bay. The reservoir was fed by three creeks, one of which had a relatively constant, year-round flow due to the contribution of several large artesian springs (Schmidt and Clark 1980). During our visits, the dominant submerged vegetation at the site was Eurasian spiked water-milfoil (*Myriophyllum spicatum*). Fringing the lakeshore were dense stands of cattail (*Typha angustifolia*). Sediment consisted of medium to coarse sand covered by a veneer of organic debris.

**Gainer Bayou.** Station 9 is located along the eastern side of FL Hwy 77 on the northern shore of North Bay. The collection site was located in an artificial tidal basin behind a concrete water control structure with two overflow pipes. During our visit on 8 November 1998, the tide was low and the tidal basin was largely dry except for two large tidal pools. Collections were made in the larger pool about 30 m northwest of the concrete water-control structure. The water depth of this pool was less than 1 m. *Balanus subalbidus*, *Callinectes sapidus* Rathbun, 1896, *Lepidophthalmus louisianensis* (Schmitt, 1935), and *Neritina usnea* (Röding, 1798) were common in the collecting area. The bottom substratum of the pool sampled consisted of a fine silt layer about 20 to 40 cm thick, overlying a coarse sand base.

### Collection Methods

Collections for hydrobiids were made using kick nets with 0.5 and 1.0 mm mesh bags. The nets were used either to dip aquatic vegetation (e.g., widgeon grass and water-hyssop) or to skim over intertidal and subtidal substrata. Samples were placed in 19-L buckets, which were partially filled with water from the collection site.

The hydrobiids (and other invertebrates) were then extracted by elutriation or by sieving with a series of screens ranging from 0.5 to 2.0 mm. In more confined areas (small marsh tidal pools), a stainless steel “tea strainer” with 1-mm mesh was employed to scoop and sieve sediments for snails.

### Reproduction

Adult males and females of each species collected from the St. Andrew Bay System were each isolated into separate 15-cm diameter finger bowls containing brackish water having a salinity similar to that of the water from which each species-group was collected. Egg capsules initially attached to shells of snails used in these observations were removed before isolation. Other substrata that might accommodate the deposition of egg capsules by various hydrobiid species were added to the bowls. These substrata included uncontaminated filamentous green algae (*Cladophora* sp.) and empty hydrobiid shells. Bowls and snails were examined daily, with water changed every 2 or 3 days or when water quality dictated (e.g., fouling by blue-green algae). When egg capsules were observed attached to the bottom or sides of a bowl, the adult snails were transferred to a clean bowl and the date recorded. These bowls were dated and maintained until the corresponding ova hatched or died. When capsules were deposited on the algae or empty hydrobiid shells, these substrata were removed from the bowl and isolated in other bowls until hatching or death of the eggs occurred. Water in bowls containing the various substrata with attached egg capsules was changed daily and the infertile or dead eggs culled. The bowls were examined daily until hatching occurred.

### General Information

Shells for scanning electron microscopy (SEM) were washed in distilled water, air-dried, and placed in a desiccator prior to sputter coating with gold film. Specimens were examined with a Jeol JSM T-330 scanning electron microscope. Morphological comments follow the terminology proposed by Hershler and Ponder (1998). When a common name is provided by Turgeon et al. (1998), we have included it.

### RESULTS AND REMARKS

Collections and ecological observations from the St. Andrew Bay System were conducted over 10 years from September 1988 through September 1998. During this study, we collected hydrobiids belonging to four genera. These are *Heleobops* Thompson, 1968; *Littoridinops*

Pilsbry, 1952; *Onobops* Thompson, 1968; and *Texadina* Abbott and Ladd, 1951. They represent six species and came from bayou, tidal marsh, and pond habitats.

***Littoridinops monroensis* (Frauenfeld, 1863)  
(Cockscorb hydrobe)**

Figure 2

**Synonymy.**—*Hydrobia monroensis* Frauenfeld, 1863, p. 1023; Pilsbry 1899, p. 87–88, Figures 17–19.—*Bythinella monroensis*, Tyron, 1870, p. 48.—*Littoridina monroensis*, Walker 1818, p. 141.—*Amnicola forsythi* Pilsbry, 1930, p. 300 (Plate 22, Figure 7).—*Amnicola oscitans* Pilsbry, 1930, p. 300–301 (Plate 22, Figure 8).—*Amnicola sablensis* Pilsbry, 1951, p. 119–120 (Plate 9, Figures 1–1c).—*Littoridina* sp., Moore 1961, p. 52.—*Littoridinops monroensis*, Thompson 1968, p. 67–74; Leigh 1974, p. 768; Heard 1982, p. 11–14 (Figures 7e, 8d); Britton and Morton 1989, p. 209, 211; Hershler and Thompson 1992, p. 70–71; Lyons 1998, p. 18; Turgeon et al. 1988, p. 61; Turgeon et al. 1998, p. 73.—*Littoridinops* sp. A, Taylor in Andrews 1977.—*Littoridinops* [sic] *monroensis*, Heard and Overstreet 1983, p. 171–174; Font et al. 1984, p. 396.

**Material examined.** St. Andrew Bay, Florida.—Station 4 (Maggie Bayou): 50+ adults (♂♂, ♀♀, juveniles), 26 August 1998.—Station 7 (Grand Lagoon Pond, snails associated with submerged and floating water-hyssop): 6 adults (1♂, 5♀♀) plus numerous empty shells, 11 December 1994; 20 adults (7♂♂, 13♀♀) plus numerous juveniles and empty shells, salinity near 0‰, 20°C, 12 January 1995; 500+ (♂♂, ♀♀, juveniles), salinity 5‰, 18.5°C, 23 November 1996; 250+ (♂♂, ♀♀, juveniles), salinity near 0‰, 17°C, 9 February 1997; 200+ adults, salinity 3.5‰, 26°C, 12 September 1998.

**Remarks.** The shells of *Littoridinops monroensis*, especially those of the females, are more robust than those of *Littoridinops palustris* Thompson, 1968 and *Littoridinops tenuipes* Couper in Haldeman, 1844. A penis, or male copulatory organ (= verge of some authors), bearing two to five more or less distinct rows of mammiform apocrine glands on the convex (right) margin and one to three subapical apocrine glands on the concave (left) margin near the distal end of penis, distinguishes *L. monroensis* from other Florida brackish water hydrobiids (Figure 2D). Difficulty existed when attempting to distinguish the shells of *L. monroensis* from those of the closely related Gulf and East coast endemic species, *L. palustris* and *L. tenuipes*, respectively.

In life, the dark body pigmentation of the females of *L. monroensis* and *L. palustris* overlaps to such an extent

that we were unable to reliably distinguish the two in the populations from the St. Andrew Bay System. However, when comparing the living males of the two species, we observed that those of *L. monroensis* had dark pigmentation that could be seen through translucent upper whorls of the shell. A dark melanistic layer covered the area around the testis and part of the digestive gland. Because *L. monroensis* commonly occurred near the surface of ponds on vegetation, perhaps this pigment layer evolved as a means of protection for the testis from ultraviolet radiation. Such a distinct dark layer in the region of the testis was not observed in the male of *L. palustris* from subtidal and tidal marsh populations at Mill, Lynn Haven, and Upper Goose bayous, where there was less direct exposure to sunlight.

**Distribution and Ecological Observations.** During our study, we observed a well-established population of *L. monroensis* on Panama City Beach in an oligohaline to lower mesohaline pond intermittently connected to the headwaters of Grand Lagoon (Station 7). Also, on two occasions, we recorded it from Upper Goose Bayou (Station 4). On those occasions, it co-occurred with *L. palustris*, *Heleobops* sp. (smooth form), and *Onobops jacksoni* (Bartsch, 1953). At the Upper Goose Bayou site, *L. monroensis* was collected on widgeon grass in a marsh pond. Because it occurs from Maryland southward throughout Florida and westward to Texas, the Bahamas, and Cayman Islands (Heard 1982, Hershler and Thompson 1992, Heard and Overstreet, personal observations), the presence of *L. monroensis* in the St. Andrew Bay System was not unexpected. Along the coast of the northern Gulf, it commonly occurs in brackish ponds, often in high densities, associated with submerged aquatic vegetation (e.g., widgeon grass and water-hyssop) and filamentous algae. It appears to be especially well adapted for living in the brackish water ponds that commonly occur on the barrier islands along the northern Gulf (Heard 1982).

Egg capsules of *L. monroensis* were deposited on algal filaments, aquatic vascular plants, and the shells of other snails (Figure 2E). The size and development of the egg capsules was about the same as for *L. palustris*, and a single embryo developed in each capsule. Depending on the temperature, a fully formed juvenile emerged from the capsule within 10 to 15 days after being deposited (Heard 1982, present study, Figure 2F–H). The incorrect report by Hershler and Thompson (1992) of a pelagic larva for this species was the result of a miscommunication from R. Heard.

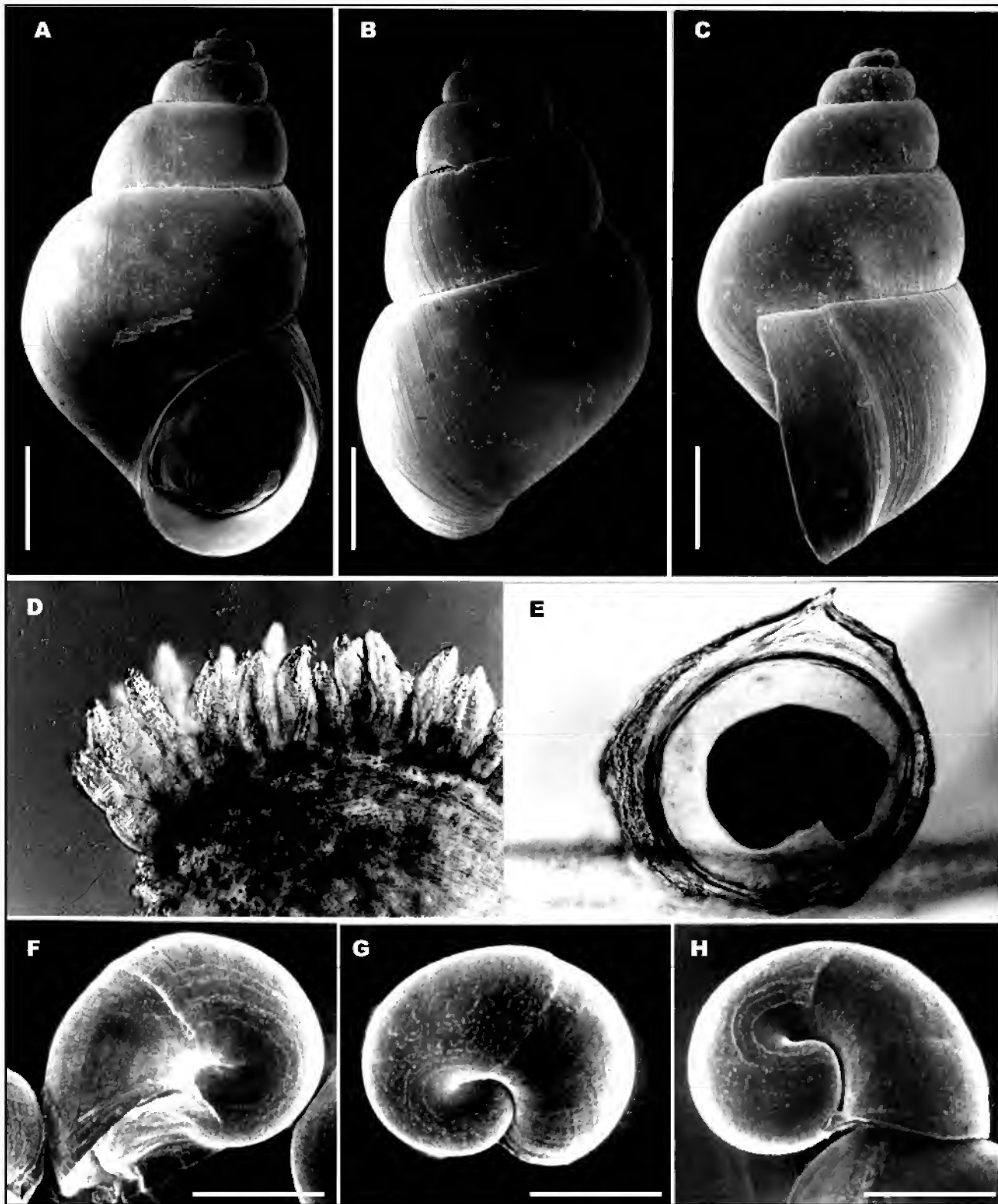


Figure 2. *Littoridinops monroensis*. A–C. Adult female, three aspects of shell (SEM). D. Male, penis, showing two to three rows of apocrine glands. E. Egg capsule on filamentous green alga. F–H. Protoconchs, various aspects of individuals hatched within 24 hr showing new growth (SEM). Scales: A–C = 500  $\mu$ m; F–H = 100  $\mu$ m.

***Littoridinops palustris* Thompson, 1968****(Bantam hydrobe)**

Figures 3, 4

**Synonymy.**—*Littoridinops palustris* Thompson, 1968, p. 65–67; Heard 1982, p. 11–14 (Figures 7e, 8d); Hershler and Thompson 1992, p. 70; Lyons 1998, p. 18; Turgeon et al., 1988, p. 61; Turgeon et al., 1998, p. 73.—*Litterodinops* [sic] *palustris*, Heard and Overstreet 1983, p. 171–174.

**Material examined.** St. Andrew Bay, Florida.—Station 1 (FL Hwy 390 at Mill Bayou, subtidal; 1–2 m depth): 40+ adults (♂♂, ♀♀), 30+ subadults, 25 October 1994; 10+ adults, 11 December 1994; 30+ adults, 3 February 1995; 25+ adults, 9 February 1997; 100+ (♂♂, ♀♀), 12 September 1998.—Station 1A (mouth of Mill Bayou at Memorial Park): 1♂, 11 December 1994.—Station 4 (Maggie Bayou): 50+ adults (♂♂, ♀♀, juveniles), 13 May 1995.—Station 5A (Lynn Haven Bayou; brackish water ditch adjacent to boat ramp): 30+ adults (♂♂, ♀♀), 13 May 1995.—Station 9 (Gainer Bayou): 15 adults (4♂♂, 11♀♀), salinity 14‰, 25°C, 7 November 1998.

**Remarks.** Some of the shells of *L. palustris* from subtidal habitats along the northern Gulf had a distinctively thickened or swollen area at or near the outer lip of the shell aperture. We have often observed this characteristic in greater than 25% of adult specimens collected from low salinity, subtidal sites in Alabama and Mississippi. Only a few individuals (Figure 3D) from the Mill Bayou population exhibited this feature, one which has not been noted in populations of *L. palustris* from the southern part of the snail's range along the Gulf coast of peninsular Florida (Thompson 1968, Heard, Overstreet, and Foster, personal observation). Also, no such condition was observed for the shells of *L. monroensis*.

The penis of *L. palustris* (Figure 4) bears a single row of five to 15 mammiform apocrine glands on the convex margin and one to three on the distal concave margin near the distal end of the penis (Thompson 1968, Heard 1982). These characteristics clearly distinguish the male of *L. palustris* from that of *L. monroensis*, which has two or more rows of mammiform apocrine glands on the convex margin of the penis. Absence of proximal apocrine glands on the concave margin distinguishes the penis of *L. palustris* from the superficially similar ones of *L. tenuipes* and of *Pyrgophorus platyrachis* Thompson, 1968. Although the species occasionally co-occur with *L. palustris*, both *L. monroensis* and *P. platyrachis* characteristically inhabit low salinity coastal ponds and tidal backwaters associated with the aquatic plants, principally widgeon grass and water-hyssop.

Of the living adult specimens of *L. palustris* examined from Mill Bayou, most males were smaller than the corresponding females. Except for two males infected with digenean parasites, the penes of the specimens were well developed. One difference noted for the Mill Bayou population and another population of *L. palustris* from Lake Shelby, a brackish lake near Gulf Shores, Alabama, was that most of the adult males had a single mammiform apocrine gland on the concave margin of the penis adjacent to its distal end.

**Distribution and Ecological Observations.**

*Littoridinops palustris* is widely distributed along the Gulf from Mississippi to southern Florida (Thompson 1968, Heard 1982), and, like *L. monroensis*, we expected to find it in the St. Andrew Bay System. It is replaced on the east coast of Florida by *L. tenuipes*, which has a range extending northward to Massachusetts (Smith 1987, Hershler and Thompson 1992).

*Littoridinops palustris* commonly occurs intertidally in the wetter parts of marshes where salinities vary from less than 1 to over 20‰. In low salinity (usually less than 10‰) areas of bays, bayous, and mouths of tidally influenced rivers, it can occur subtidally to depths greater than 2 m. In these subtidal habitats, it is usually associated with plant detritus or with submerged vegetation, such as widgeon grass and water celery, or eel grass (*Vallisneria americana*).

There is no true planktonic larval or free swimming veliger stage for *L. palustris*. The egg capsules were relatively large and were often deposited on the shells of other individuals of *L. palustris* and other associated hydrobiids. A single embryo developed in each spherical egg capsule. After about 2 to 3 weeks, depending on temperature, a small, fully formed juvenile emerged (Heard 1982). The newly hatched young, and even the adult stage, can be dispersed by clinging to the surface film or to small pieces of plant material being transported by tidal currents. On several occasions, one of us (RWH) collected numerous small juveniles and a few adult specimens in surface-plankton tows from Davis Bayou, Mississippi.

***Heleobops* sp. A**

Figures 5–7

**Synonymy.**—*Heleobops* sp. (Forms A, B, C), Heard 1982, p. 13.—*Heleobops* sp., Hershler and Thompson 1992, p. 61.—*Heleobops* sp., Heard and Kinsella 1995, p. 97, 101.—“undescribed species of *Heleobops*,” Heard and Overstreet 1983, p. 171.

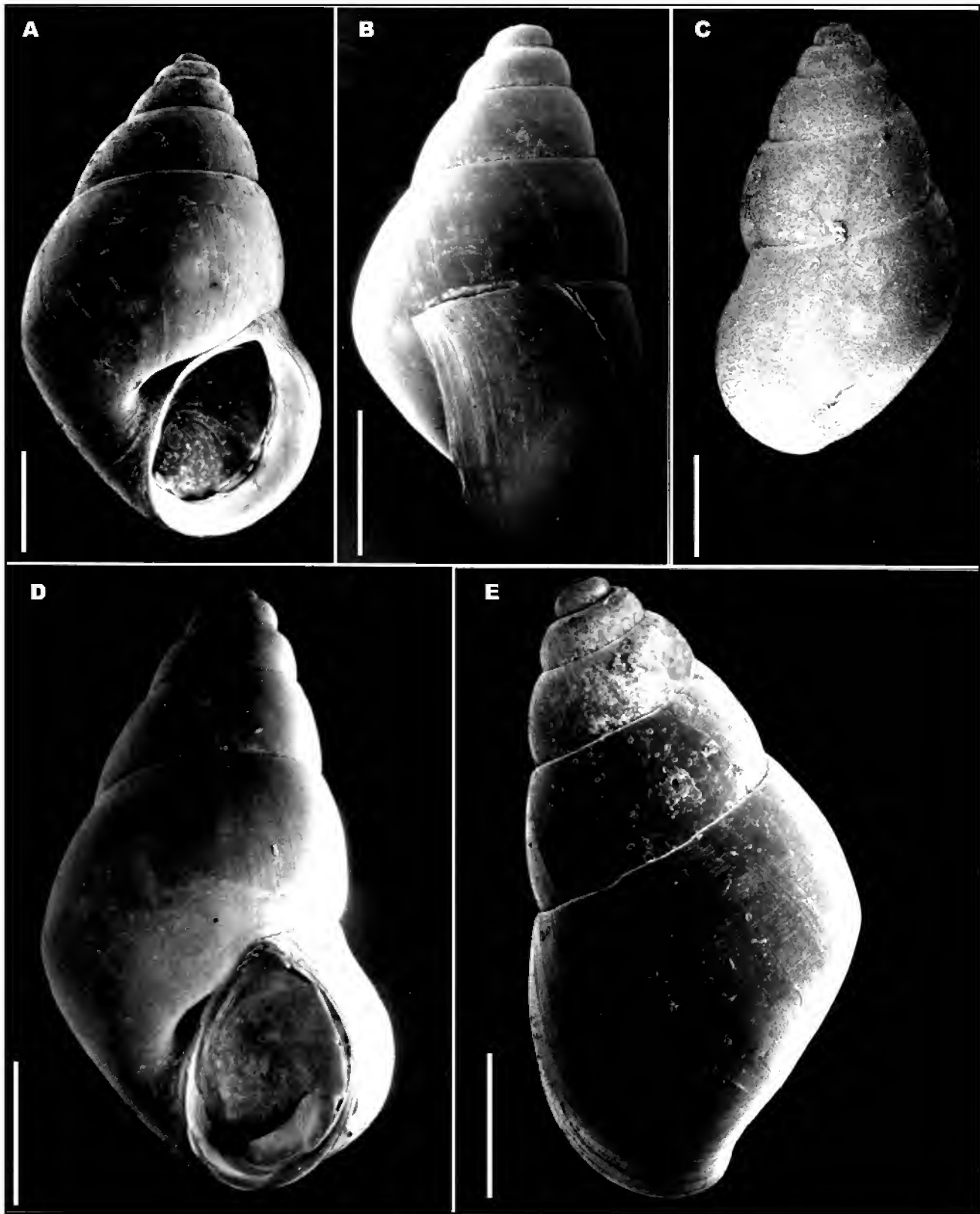


Figure 3. *Littoridinops palustris*. Shells of adult females (SEM). A–E. Various aspects. B, C. Note swollen shell behind outer lip, characteristic of subtidal forms. Scale: A–E = 500  $\mu$ m.

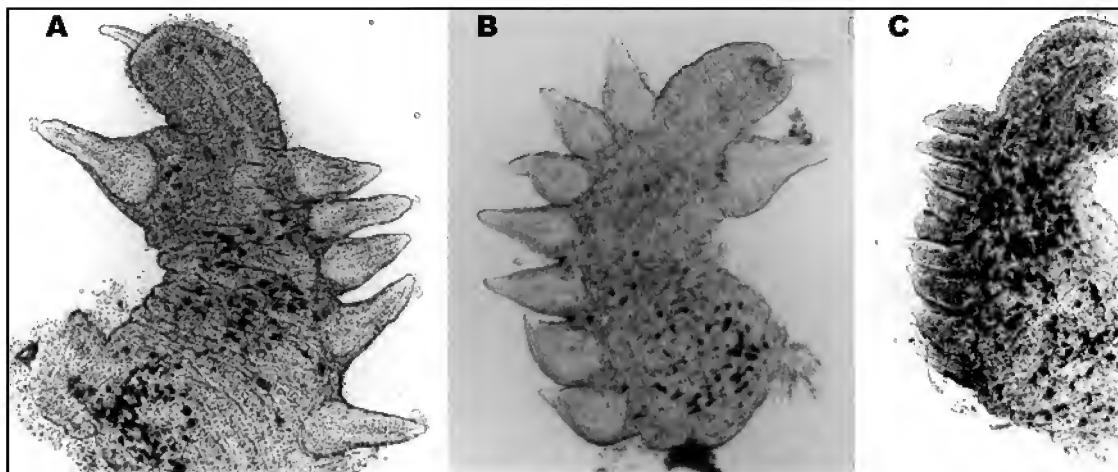


Figure 4. *Littoridinops palustris*. Male, penis, showing variation in the single row of apocrine glands on convex margin. A. Row of five. B. Row of seven. C. Row of nine.

**Material examined.** St. Andrew Bay, Florida.—Station 1 (FL Hwy 390 at Mill Bayou; subtidal, 1–2 m depth, pale orange, striate form): 50+ adults (18♂♂, 32+♀♀), 25 October 1994; 30+ subadults; 10+ adults, 11 November 1994; 30+ adults (♂♂, ♀♀), 3 February 1995; 25+ adults (♂♂, ♀♀), 9 February 1997; 100+ (♂♂, ♀♀), 12 September 1998.—Station 1A (mouth of Mill Bayou at Memorial Park): 1♂, 11 December 1994.—Station 4 (Maggie Bayou): 100+ subadults (mostly smooth form, with a few individuals intermediate between striate and smooth forms), 13 May 1995.—Station 5A (Lynn Haven Bayou; brackish water ditch adjacent to boat ramp): 30+ adults (♂♂, ♀♀) (grayish smooth form), 13 May 1995.—Station 9 (Gainer Bayou): 50+ adults (♂♂, ♀♀), salinity 14‰, 25°C, 8 November 1998.

**Remarks.** *Heleobops* sp. A appears to represent a recently evolved species derived from ancestral stock also common to *Heleobops carrikeri* Davis and McKee, 1989 during or after the re-emergence of the Florida Peninsula. *Heleobops* sp. A is distinguished from *H. carrikeri* by having a small, poorly developed apocrine gland on the penial lobe just distal to the last large apocrine gland. Populations of *H. carrikeri* are known from only the Chesapeake Bay side of Delmarva Peninsula (Maryland).

*Heleobops docima* Thompson, 1968 is the only other member of the genus known from Florida. It occurs in central Florida southward to the Bahamas and some of the northern Caribbean islands (Hershler and Thompson 1992), and its range appears to overlap that of *Heleobops* sp. A south of the Suwannee River. Although the shells of the two species are nearly indistinguishable, the male of *H. docima* can be separated from that of *Heleobops*

sp. A by the lack of apocrine glands on the distal third of the penis (see Figure 38 in Thompson 1992).

There appear to be two geographical forms of *Heleobops* sp. A, and these are distinguished by the shape of the anterior penial lobe on the penis. A form characterized by a “keel-shaped” lobe (see Figure 8f in Heard 1982) was apparently confined to an area just east of the Apalachicola River, Florida, southward to at least Tampa Bay. The other form, well represented in the St. Andrew Bay System, has a finger-like anterior penial lobe (Figures 6E, F, 7B). Its known range extends from just east of the Apalachicola River westward to the Chandeleur Islands, Louisiana, immediately east of the mouth of the Mississippi River.

Based largely on observations of the subtidal population of *Heleobops* sp. A (striate form) from Mill Bayou, we consider members of the striate population conspecific with *Heleobops* Forms A and B (smooth shell) and Form C (striate shell) of Heard (1982) and also *Heleobops* sp. (smooth shell form) previously reported from the headwaters of the St. Andrew Bay System by Hershler and Thompson (1992). Naturally occurring adults, newly hatched young, and juveniles were maintained in laboratory culture for several months. Study of the shell sculpture of these specimens (Figure 6D) confirms that the striate form of *Heleobops* sp. A from Mill Bayou is conspecific with *Heleobops* Forms A, B, and C *sensu* Heard (1982). These two shell forms represent intertidal, soft substrata (Forms A and B), and subtidal, sand-substrata (Form C) ecophenotypes. Additional circumstantial evidence that the striations on the shell were influenced by environmental conditions (chemical erosion or mechanical abrasion) was suggested by the pres-



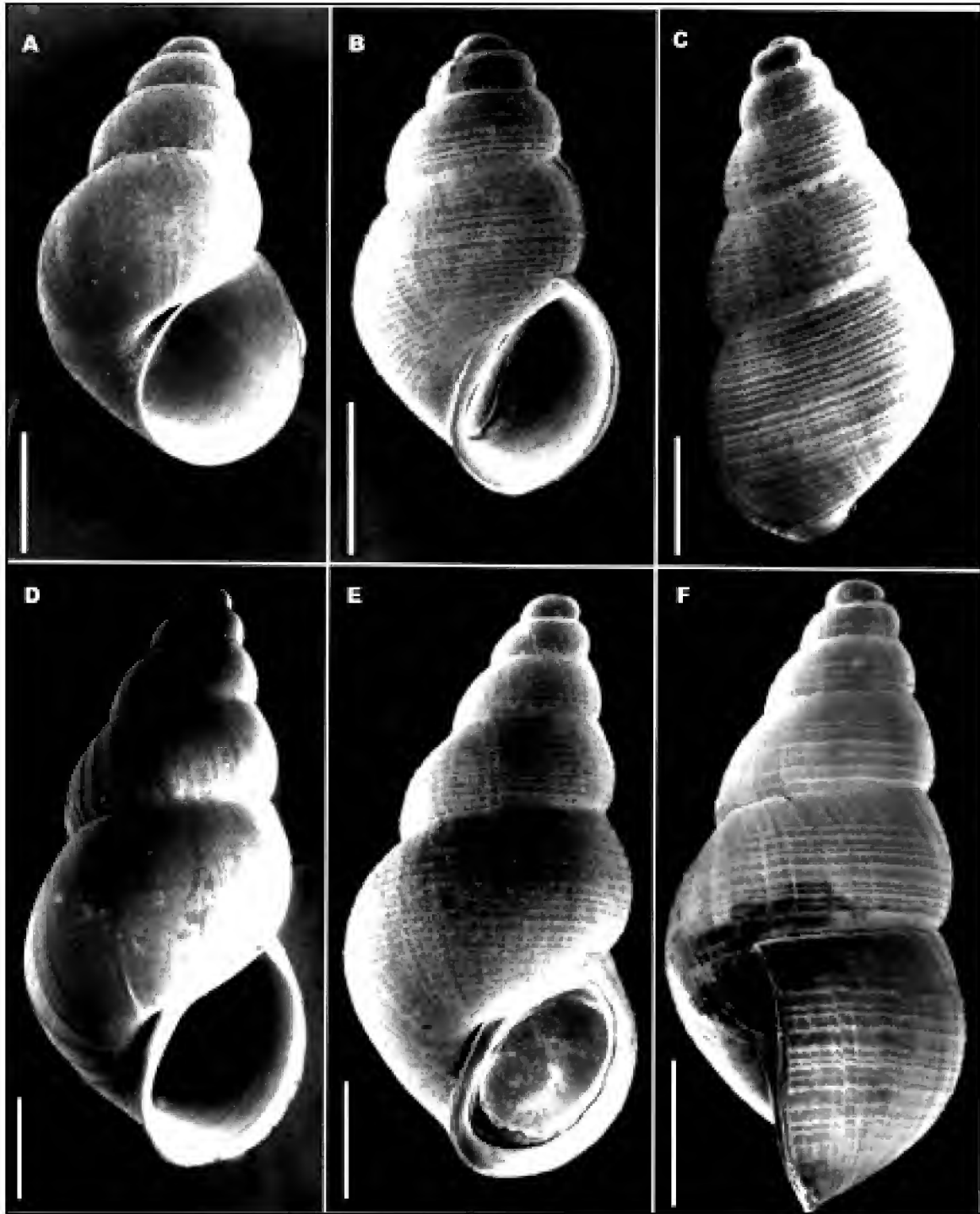


Figure 5. *Helicobops* sp. A. Shells of adults (SEM). A. Smooth-shelled male. B. Striate-shelled male. C. Striate-shelled female. D. Smooth-shelled female. E. Striate-shelled female, showing operculum. F. Striate-shelled female. Scale: A–F = 500  $\mu$ m.



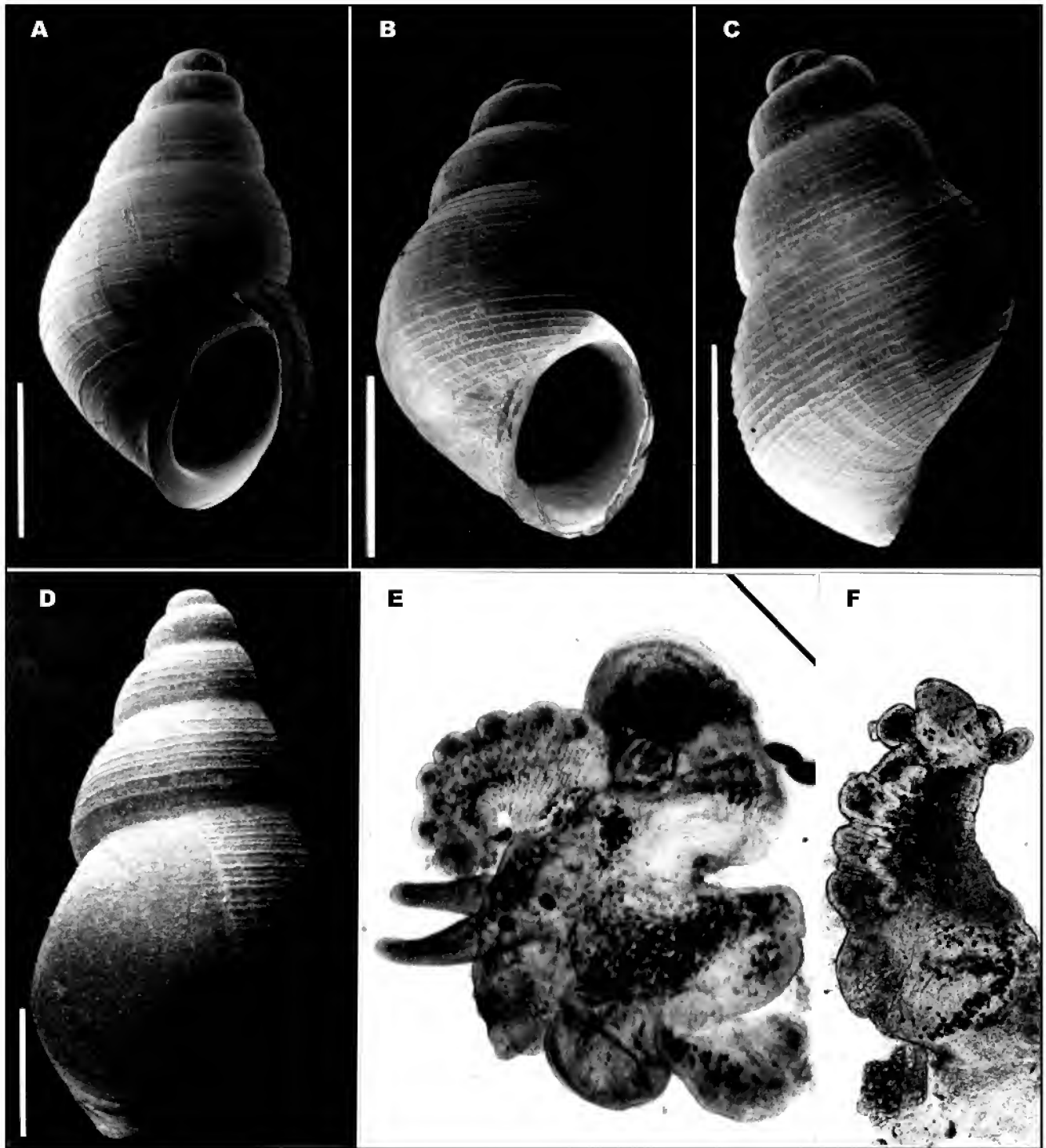


Figure 6. *Helicobops* sp. A. A–D. Shell (SEM). A–C. Male, various aspects striate-shelled form. C. Dorsal aspect of juvenile. D. Dorsal aspect of adult female showing transition from striate to smooth form that occurred when individual was maintained in laboratory culture for two months. E. Male individual removed from shell showing entire body, including penis. F. penis. Scale: A–D = 500  $\mu$ m.

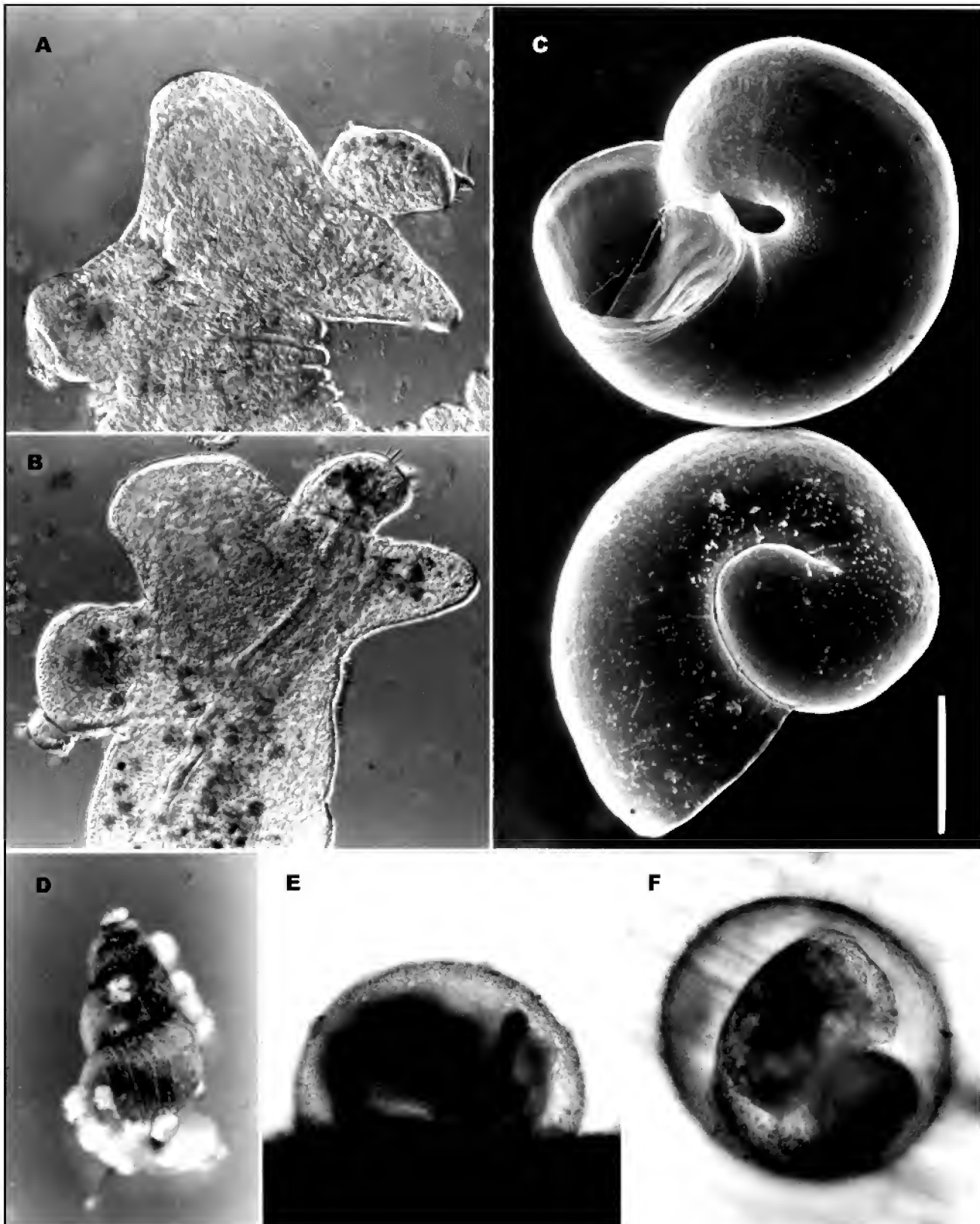


Figure 7. *Heleobops* sp. A. A. Penis, showing terminal stalked apocrine gland with pressure. B. Penis, showing terminal apocrine gland and associated duct, with pressure. C. Recently hatched striate form showing two aspects of protoconch. D. Egg capsules of marsh-type individual on another marsh-type individual. E. Close-up of egg capsule of marsh-type individual on marsh-type individual containing developing juvenile. F. Close-up of egg capsule of striated type containing developing juvenile. Scale: C = 100  $\mu$ m.

ence of similar orange-edged striations on the upper whorls in some individuals of *Texadina sphinctostoma* which co-occurred with *Heleobops* sp. A at the Mill Bayou site.

**Distribution and Ecological Observations.** One of us (RWH) has previously collected striated specimens (Form C of Heard 1982) from a small brackish pond on Horn Island, Mississippi, during September 1975 and from the upper part of Perdido Bay, Florida, during June 1980. Both of these collections were made in water depths ranging from 1 to 2 m. At all three collection sites, the striate shell form (Figures 5B, C, E, F, 6A–C) occurred in salinities usually less than 10‰ and on bottoms with a largely coarse quartz-sand substratum. In Perdido Bay, as in Mill Bayou, the striate form of *Heleobops* sp. A co-occurred with *T. sphinctostoma* and *L. palustris*.

During March of 1995, we discovered mesohaline populations of the smooth-shell form (Figure 5A, D) in several intertidal, tidal marsh habitats along the southern edge of West Bay and the eastern edges of North Bay (Stations 3, 4, and 5). In the more brackish habitats of West Bay, intertidal marsh populations of *Heleobops* sp. A co-occurred with *L. palustris* and *O. jacksoni*. In the higher salinity habitats of West Bay, *Heleobops* sp. A was found with the pyramidelid *Sayella* cf. *adamsi* and the pototomid horn snail *Cerithidea scalariformis* (Say, 1825).

*Heleobops* sp. A, like *L. monroensis* and *L. palustris*, deposits relatively large egg capsules, 0.34–0.41 mm in diameter, which contain a single embryo (Figure 7D–F). At room temperature (24–27 °C), the egg capsules hatched, producing fully formed juveniles within 11 to 15 days (Figure 7C). At the Mill Bayou (FL Hwy 390) site, egg capsules were observed on the shells of *Heleobops* sp. A as well as on those of the co-occurring hydrobiids *T. sphinctostoma* and *L. palustris*.

Under natural conditions, *Heleobops* sp. A most readily used the available shells of other hydrobiids for capsule deposition. We have observed juvenile and even adult shells of other hydrobiids so heavily fouled by *Heleobops* sp. A egg capsules, especially on the operculum or around the large body whorl, that movement and feeding of the snails were greatly impeded, often with fatal consequences. In some instances, we estimated that the combined mass of egg capsules was greater than that of the juvenile of *L. palustris* or *T. sphinctostoma* to which it was attached. A formal description of *Heleobops* sp. A with additional information on its ecology and ecophenotypic variation will be the subject of another report.

***Texadina sphinctostoma* (Abbott and Ladd, 1951)  
(Narrowmouth hydrobe)**

Figures 8–10

**Synonymy.**—*Littoridina* (*Texadina*) *sphinctostoma*, Abbott and Ladd 1951, p. 335, Figures 1–12; Solem 1961, p. 74; Garcia-Cubas, A. 1963, p. 43 (Plate 2, Figure 9); 1968, p. 34; Andrews 1971, p. 62.—*Littoridina sphinctostoma*, Moore 1961, p. 52; Traver and Dugas 1973, p. 11, 12, 16, 19, 20, 27; Dugas et al. 1974, p. 1, 6, 13, Figure 9.—*Texadina sphinctostoma*, Taylor 1966, p. 182, 196; Abbott 1974, p. 79; Andrews 1977, p. 84; Cooley 1978, p. 18, 64; Heard 1979, p. 311–312; 1982, p. 12, 14–15 (Figures 7a, 8h); Britton and Morton 1989, p. 209, 211; Hershler and Thompson 1992, p. 102–105 (Figures 67, 68); Lyons 1998, p. 18; Turgeon et al. 1988, p. 63; Turgeon et al. 1998, p. 76.

**Material examined.** St. Andrew Bay, FL.—Station 1 (FL Hwy 390 at Mill Bayou; subtidal, 1–2 m depth): 100+ adults (♂♂, ♀♀), 30+ subadults, 25 October 1994; 10+ adults (3♂♂, 7♀♀), 11 December 1994; 150+ adults (♂♂, ♀♀), 3 February 1995; 50+ adults (♂♂, ♀♀), 9 February 1997; 100+ (♂♂, ♀♀), 12 September 1998.—Station 1A (mouth of Mill Bayou at Memorial Park; subtidal, 1–1.5 m depth): 75+ adults (♂♂, ♀♀), 11 December 1994.

**Remarks.** The relatively small and constricted aperture of the shell of an adult specimen of *T. sphinctostoma* (Figure 8A–D) easily distinguishes that species from *Texadina barretti* (Morrison, 1965) and most other brackish water hydrobiids occurring along the northern Gulf. Juveniles of *T. sphinctostoma* lack the constricted aperture characteristic of adults. The turbonate shell shape of juveniles of *T. sphinctostoma* (Figure 8E–F) distinguishes them from juveniles of the more conically shaped *T. barretti*.

The male penis of *T. sphinctostoma* is similar to that of *T. barretti*, but it has five to six rather than three to four suction cup-like apocrine glands on its convex margin (Figure 9A–C). Cooley (1978) incorrectly listed *T. sphinctostoma* in the Pyramidellidae, the same family of parasitic snails to which Morrison (1965) incorrectly assigned *T. barretti* when he originally described it as a member of the genus *Odostomia* Fleming, 1813.

**Distribution and Ecological Observations.** *Texadina sphinctostoma* was originally described from San Antonio Bay, Texas, by Abbott and Ladd (1951). La Laguna de Terminos on the coast of Campeche, Mexico, is the western known occurrence for this hydrobiid (Garcia-Cubas 1963, 1968). This species was also known from the brackish waters of Louisiana, Mississippi, Ala-

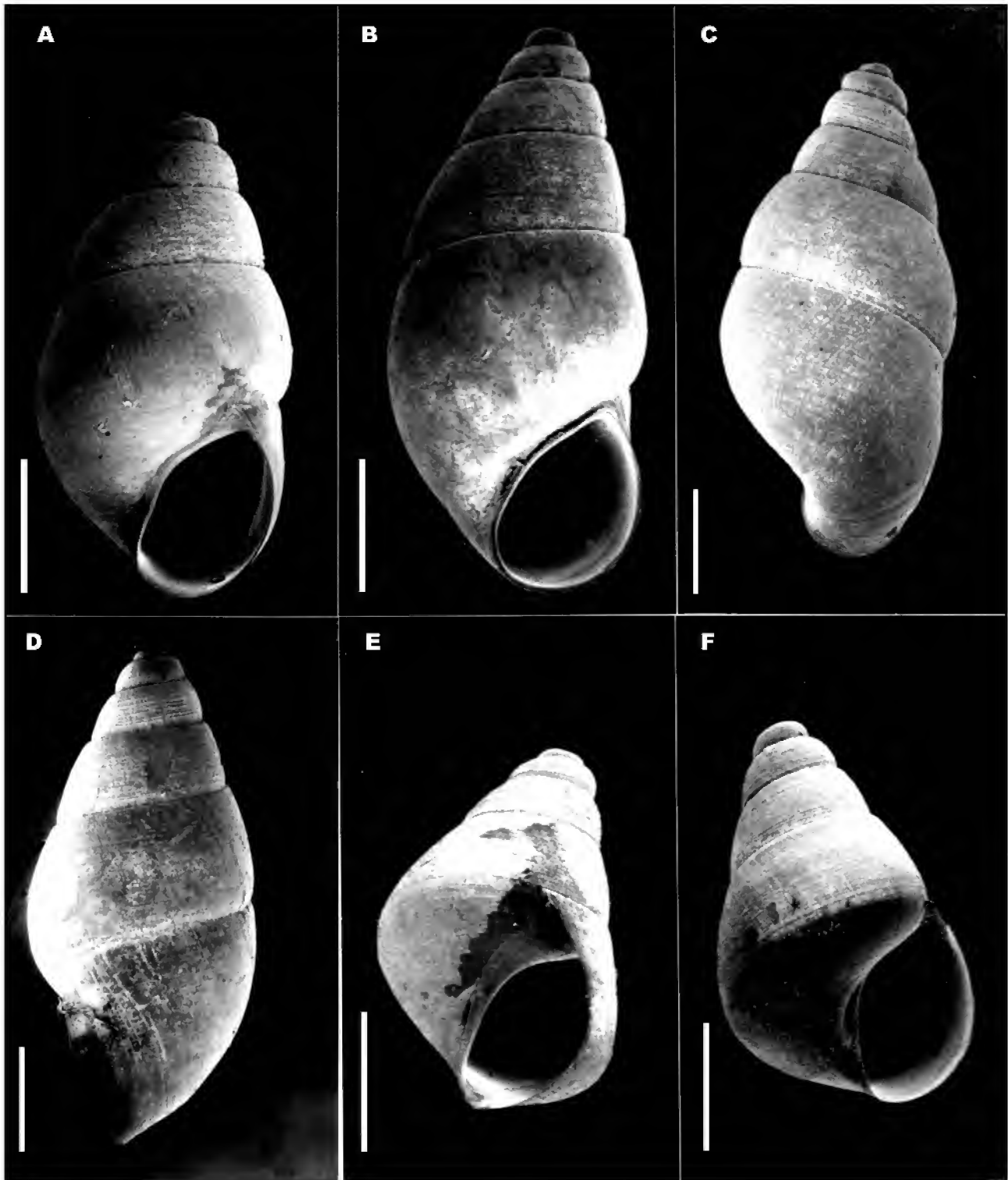


Figure 8. *Texadina sphinctostoma*. Shells (SEM). A–D. Various aspects of shell of four females. E. Early juvenile. F. Older juvenile. Scale: 500 μm.

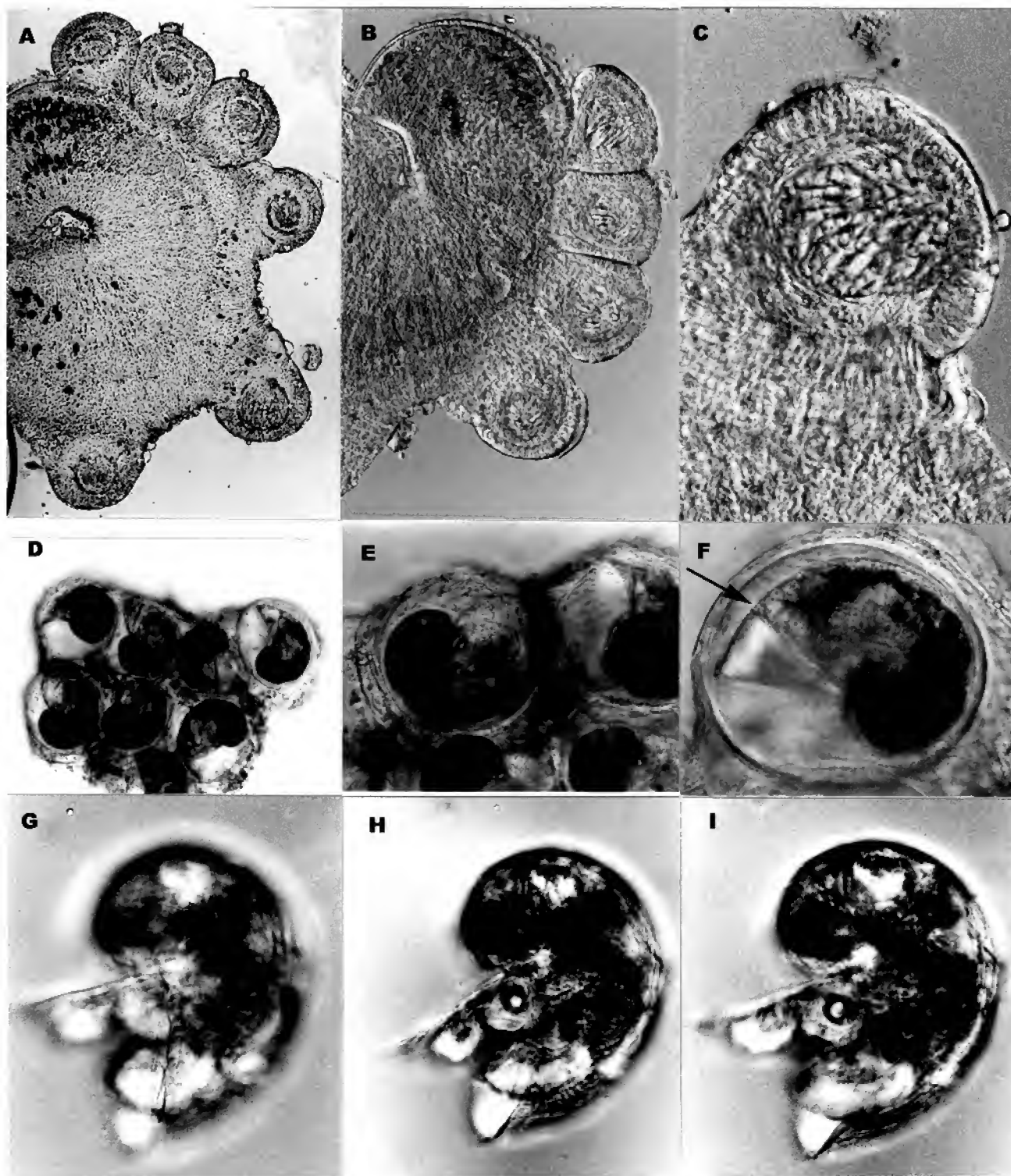
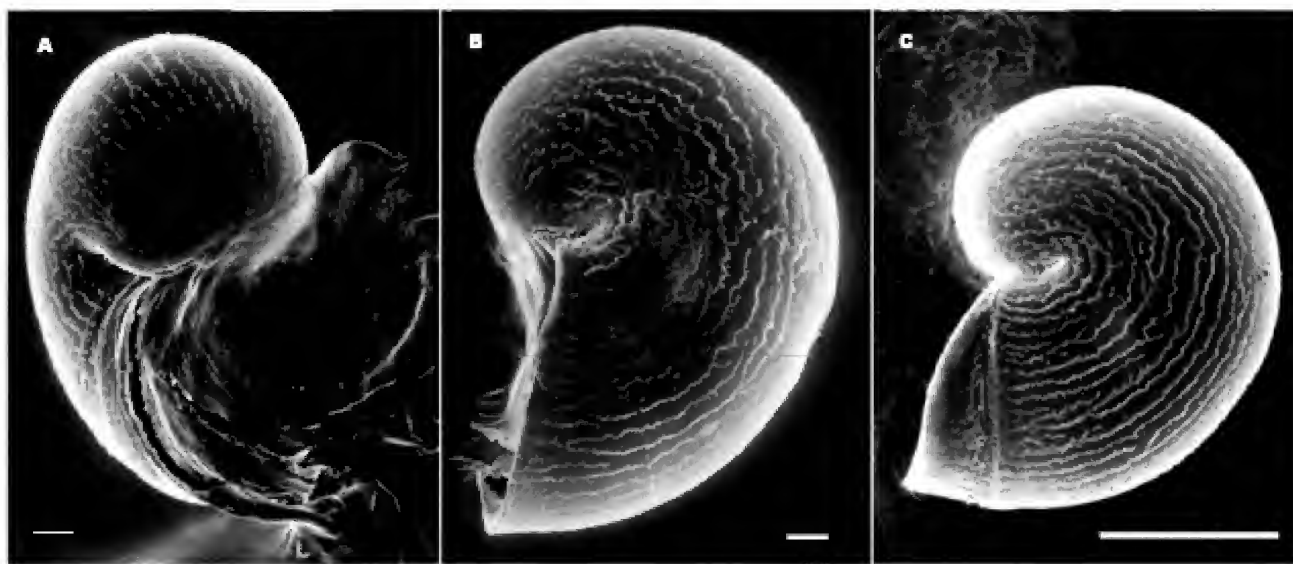


Figure 9. *Texadina sphinctostoma*. A–C. Male. A. Male, penis, showing “sucker-like” apocrine glands. B. Same, showing gonad and four distal-most apocrine glands. C. Enlargement of an apocrine gland. D–E. Egg capsules. D. Cluster of eight egg capsules from surface of *T. sphinctostoma* shell. E. Close-up of egg capsule cluster. F. Enlargement of egg capsule indicating recent shell growth (see arrow) in developing protoconch. G–I. Different planes of view of same shelled-veliger. G. Peripheral plane aspect. H. Plane toward mid-plane, showing clear statocyst adjacent to operculum. I. Near mid-plane aspect, also showing statocyst.





**Figure 10.** *Texadina sphinctostoma*. A–C. Shelled-veliger showing architecture of protoconch (SEM). C. Note recent differential growth of lip. Scales: A, B = 10  $\mu$ m; C = 50  $\mu$ m.

bama, and extreme West Florida (Cooley 1978, Hershler and Thompson 1992).

*Texadina sphinctostoma* co-occurs, often in large numbers, with the hydrobiid species reported as *Probythinella protera* Pilsbry, 1953 in the low salinity bayous and bay habitats of Texas, Louisiana, Mississippi, and Alabama (Solem 1961, Morrison 1965, Dugas et al. 1974, Heard 1979, Vittor 1979). Based on such collections of *P. protera* from Lake Pontchartrain, Solem (1961) found that some mature specimens had a constricted aperture like that reported for the adult of *T. sphinctostoma*. He suggested that some similar environmental factor or factors may have induced this condition in both species.

Our present records on *T. sphinctostoma* from Mill Bayou extend its eastern range from Escambia Bay (Cooley 1978) eastward to St. Andrew Bay, a distance of about 160 km. In the laboratory, we observed that some of the females deposited egg capsules on the shells of other specimens and on the finger bowls in which they were being maintained (Figure 9D–F). These capsules hatched as free-swimming, shelled-veligers in 8 days at room temperature (Figures 9G–I, 10A–C).

***Texadina barretti* (Morrison, 1965)  
(Boone hydrobe)**

Figure 11

**Synonymy.**—*Odostomia barretti* Morrison, 1965, p. 218, Figure 4 (not *Odostomia barreti* Morlet, 1885).—*Hydrobia booneae* Morrison, 1973, p. 28; Turgeon et al. 1988, p. 61.—*Texadina barretti*, Taylor in Andrews

1977 p. 82; Heard 1982, p.15; Britton and Morton 1989, p. 209; Hershler and Thompson 1992, p.103; Lyons 1998, p. 18; Turgeon et al.1998, p.76.

**Material examined.** St. Andrew Bay, FL.—Station 1 (Mill Bayou at FL Hwy 390; subtidal, 1–2 m depth): 3 adults (1 $\sigma$ , 2 $\phi$ ), 11 December 1994; 1 adult ( $\sigma$ ), 4 April 1995; 1 adult ( $\sigma$ ), 23 November 1996; 4 adults ( $\sigma$ ,  $\phi$ ), 9 February 1997; 19 adults (3 $\sigma$ , 16 $\phi$ ), 10+ juveniles, salinity 1‰, 24 °C, 26 August 1998.

**Remarks.** Originally, *T. barretti* was described by Morrison (1965) from Lake Pontchartrain, Louisiana, as a member of the pyramidellid genus *Odostomia*. Later, Morrison (1973) transferred this species to Hydrobiidae in the genus *Hydrobia* Hartman, 1821; however, since the specific name “*barretti*” was a junior homonym of the older name *Hydrobia barreti* Morlet, 1885, he proposed the replacement name *Hydrobia booneae* Morrison, 1973 to accommodate the Gulf species. Based on the structure of the male penis, Taylor (in Andrews 1977) transferred *H. booneae* to the genus *Texadina*, resulting in the restoration of the original specific name, *barretti*.

The distinctive, seemingly stalked, sucker-like apocrine glands on the convex margin of the penis of *T. barretti* and *T. sphinctostoma* are characteristic of the genus *Texadina* and distinguish them from other brackish water hydrobiids of the northern Gulf of Mexico. *Texadina barretti* is distinguished from the co-occurring *T. sphinctostoma* by having 1) a typical non-constricted aperture, 2) a smooth, glossy shell lacking striations on the whorls; however, under SEM preparation, subadults and juveniles do exhibit faint spiral striations as seen in Figure 11A–D, and 3) fewer, three to four rather than

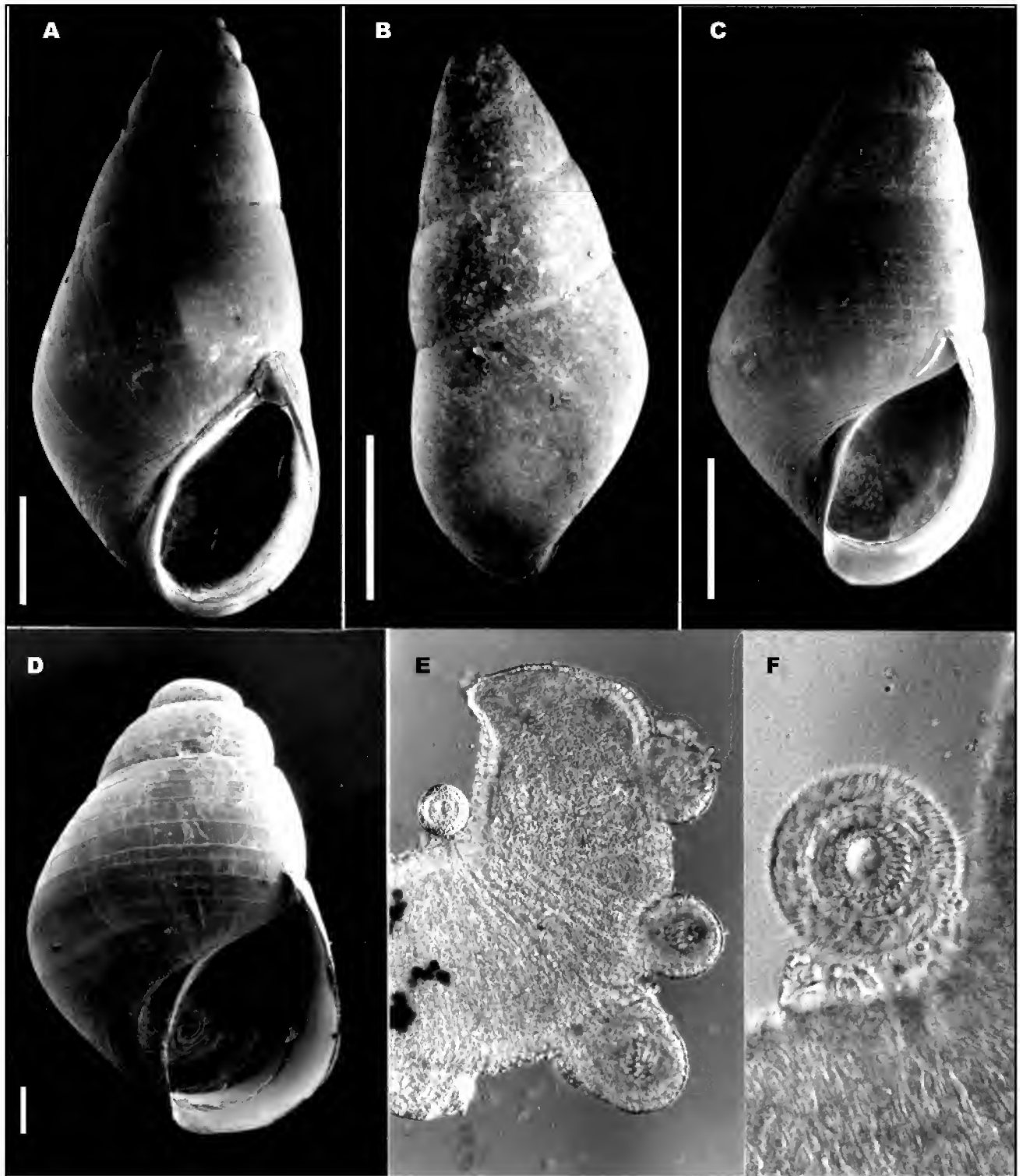


Figure 11. *Texadina barretti*. A–D. Shells (SEM). A, B. Adults. C. Subadult. D. Juvenile; compare with juvenile of *Texadina sphinctostoma*. E. Male, penis showing apocrine glands; note single trichodinid ciliate symbiont. F. Close-up of trichodinid peritrich symbiont. Scales: A, C = 500  $\mu$ m; B = 1 mm; D = 100  $\mu$ m.

five to six, sucker-like apocrine glands on the convex margin of the penis (Figure 11E).

**Distribution and Ecological Observations.** The presence of *T. barretti* in Mill Bayou extends its eastward range from Heron Bay in western coastal Mississippi (Morrison 1973) to St. Andrew Bay, a distance of approximately 370 km. Galveston Bay, Texas, is its reported western range limit (Morrison 1973). We also have two records of *T. barretti* from Jackson County, Mississippi (Davis Bayou, Gulf Coast Research Laboratory [GCRL] boat basin, and the Escatawpa River).

In a shallow brackish water lake near Port Fouchon, Louisiana, we found *T. barretti* associated with the callianassid ghost shrimp *Lepidophthalmus louisianensis* in wet sand along the edge of the shoreline. On several occasions at this site during June 1980, we observed specimens of *T. barretti* in the upper, constricted part of this ghost shrimp's burrow (Heard in Britton and Morton 1989). In all the other locations, Texas (Galveston Bay), coastal Mississippi (Davis Bayou), and Florida (Mill Bayou), where *T. barretti* occurred, populations of *L. louisianensis* also occurred (Heard and Foster, personal observations).

During September 1998, we made collections at Station 1 (Mill Bayou) specifically to determine whether or not the distribution of *T. barretti* was directly related to the presence of *L. louisianensis*. Although burrows of this callianassid occurred throughout the collecting area around the FL Hwy 390 bridge, they were far less dense in the deeper (1.5–2.0 m) parts of the bayou. We made eight 5-m sweeps with a 0.5 mm mesh kick net in this part of the bayou and four 5-m sweeps in the shallow sandy shoal areas where there were large concentrations of burrows (greater than 100 burrow openings/m<sup>2</sup>). The eight sweeps from deeper water yielded relatively large numbers of *Heleobops* sp. *A.*, *L. sphinctostoma*, and *L. palustris* but only four specimens of *T. barretti*. In contrast, the four sweeps over the sandy shoal areas with callianassid burrows produced 26 specimens of *T. barretti*, further suggesting that *T. barretti* associates with *L. louisianensis*. Notwithstanding, additional field and laboratory observations are needed to determine whether or not a true symbiotic relationship exists between *L. louisianensis* and *T. barretti* or whether the observations at Port Fouchon resulted from the snails fortuitously entering the burrows to avoid dessication during low tide.

We maintained several adult male and female specimens of *T. barretti* collected from upper Galveston Bay in the laboratory for several weeks. During that period, females deposited egg capsules on the bottom surface of a large glass finger bowl. The capsules were similar in

size and structure ("fried egg-shaped") to those of *T. sphinctostoma* and each contained a single ovum. Within 7 days of deposition, a free swimming, shelled-veliger emerged from each capsule.

***Onobops jacksoni* (Bartsch, 1953)**

(Fine-lined hydrobe)

Figures 12A–H

**Synonymy.**—*Onoba jacksoni* Bartsch, 1953.—*Onobops jacksoni*, Thompson 1968; Hershler and Thompson 1992; Lyons 1998, p. 18; Turgeon et al. 1988, p. 61; Turgeon et al. 1998, p. 74.—*Onobops* cf. *jacksoni*, Heard 1982.—*Cingula jacksoni* Bartsch, 1953 as erroneous listing of Turgeon et al. 1988 (see Turgeon et al. 1998, p. 219).

**Material examined.** St. Andrew Bay, FL.—Station 2 (Upper Goose Bayou): 100+ adults and subadults, 13 March 1995; 50+ adults (♂♂, ♀♀), 25+ subadults, 12 August 1998.—Station 4 (Maggie Bayou): 75+ adults (♂♂, ♀♀), 50+ subadults, 13 May 1995.—Station 5A (Lynn Haven Bayou): 50+ adults and subadults, 12 March 1995; 23 adults, 25+ subadults, 13 May 1995.

**Remarks.** The relatively small, elongate shell with incised whorls (Figure 12A–D) and the simple, unornamented penis of the male distinguish the two Florida species of *Onobops* from those of other hydrobiid genera from the Florida Gulf coast. *Onobops jacksoni* is similar to *Onobops crasus* Thompson, 1968, the only other member of the genus. *Onobops crassus* was described from the southwest coast of Florida, and *O. jacksoni* can be distinguished from it by having 22 to 24 gill lamellae rather than 26 to 28 and usually five rather than four opercular whorls (Thompson 1968).

**Distribution and Ecological Observations.** *Onobops jacksoni* appears to be a common resident of the mesohaline marshes and backwaters associated with the St. Andrew Bay system. It has been found commonly in the wet, muddy, intertidal parts of mesohaline tidal marshes and mangrove swamps from Maryland southward to Florida and westward to Mississippi (Heard 1982, Hershler and Thompson 1992).

The female of *O. jacksoni* deposits her "fried egg-shaped" egg capsules on the surfaces of empty shells, wood, leaves, and shells of various living hydrobiids (Figure 12E), including *O. jacksoni*. Similar to capsules of other known estuarine hydrobiids from the southeastern US, those of *O. jacksoni* contain a single ovum (Heard 1982, Davis and McKee 1989). Like those of *T. barretti* and *T. sphinctostoma*, the capsule of *O. jacksoni* is distinctly smaller than those known for species in the



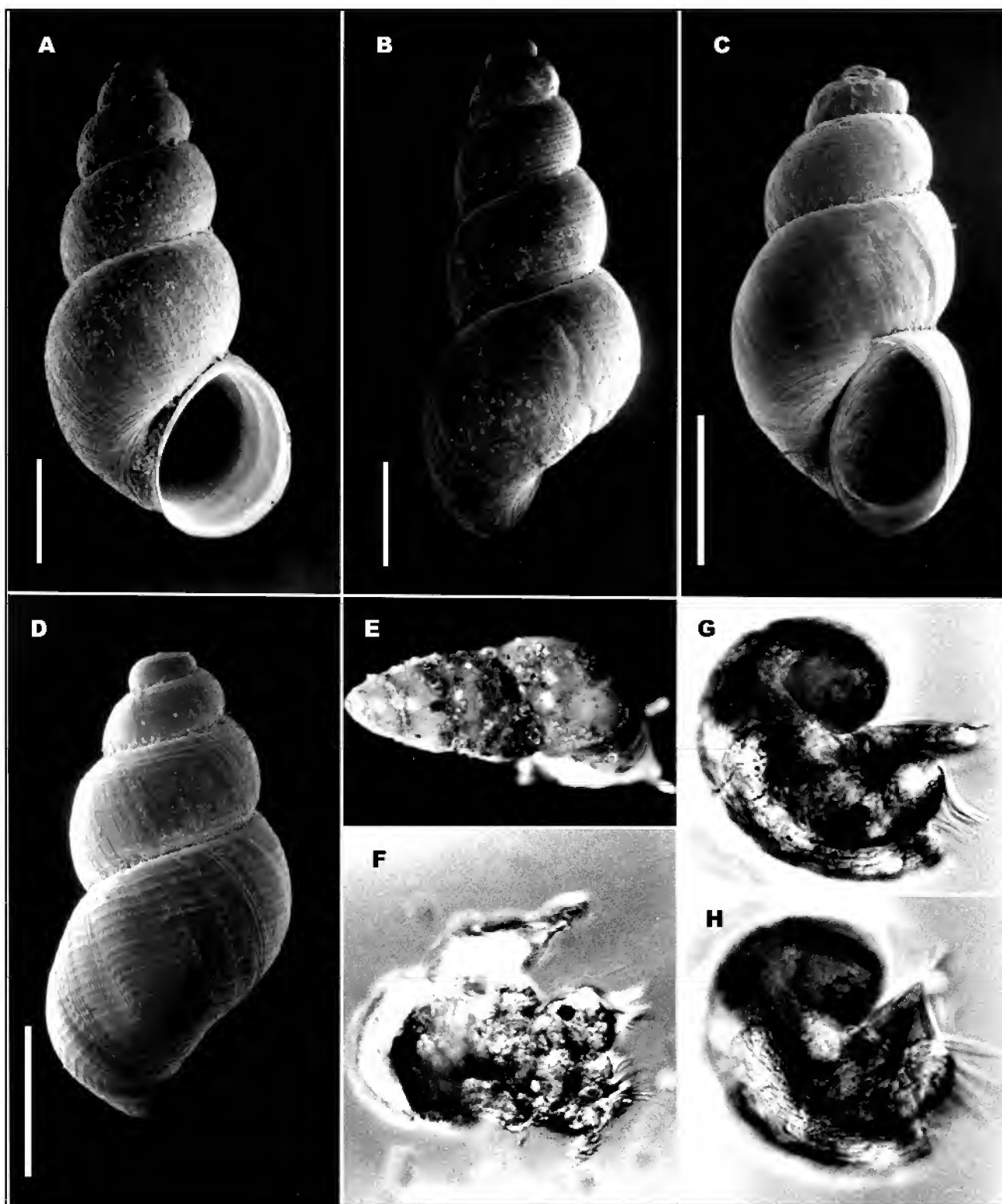


Figure 12. *Onobops jacksoni*. A–D. Shell (SEM), various aspects. A, B. Adults. C, D. Subadults. E. Egg capsules on shell of same species. F. Veliger, with shell broken to reveal dorsum of snail. G. Veliger, mid-plane aspect, showing side of operculum. H. Veliger, peripheral plane aspect. Scale: A–D = 500  $\mu$ m.

genera *Heleobops*, *Littoridinops*, and *Spurwinkia* (Davis, Mazurkiewicz, and Mandracchia, 1982). The ovum of *O. jacksoni* develops into a shelled-veliger with a developed protoconch, which hatches from the capsule after 7 to 14 days (Figure 12F–H), depending on the temperature. As previously reported, the protoconch has longitudinal striae, or raised ridges, on its surface (see Figure 5E, G, H in Davis and McKee 1989).

## DISCUSSION

With the addition of *Texadina barretti*, nine hydrobiid species are now known from the tidewater and marine environs of Florida. Table 1 lists these species and their general distribution in Florida coastal waters.

The hydrobiid populations of *T. barretti* and *T. sphinctostoma* that we observed at Mill Bayou may represent the remnants of larger stocks that may have once existed in the more extensive brackish habitats in the upper east St. Andrew Bay System prior to the construction of Deer Point Dam. Much of the oligohaline and lower mesohaline bay bottom habitat was lost when the Dam was constructed in 1961, cutting off the upper, northeastern part of the Bay.

To determine if low salinity/freshwater tolerant species such as *Littoridinops monroensis*, *Pyrgophorus platyrachis*, or *Probythinella protera* were present, we made an extensive collection of invertebrates from shallow water habitats of the Deer Point Reservoir adjacent to the Dam (Station 8) during November 1994; however, no hydrobiid of brackish origin was observed. With one exception, we found that the aquatic fauna present in the reservoir was typically freshwater. The euryhaline mysid *Taphromysis bowmanni* Băcescu, 1961 appeared to be the only Bay species that was able to acclimate to the freshwater conditions now present in the Reservoir. The hydrobiid *Notogillia wetherbyi* (Dall, 1885), the pleurocerid *Elimia* cf. *floridensis*, and the planorbid *Planorbella scalaris* (Jay, 1839) were common on submerged vegetation and on the shallow sand bottom of the Reservoir. These freshwater gastropods appear to be characteristic of the streams and springs that empty into the Reservoir.

### Possible Presence of Other Estuarine Hydrobiids in the St. Andrew Bay System

At least three species belonging to three different hydrobiid genera, *Littoridina* Souleyet, 1852; *Pyrgophorus* Ancey, 1888; and *Probythinella* Thiele, 1928, are presently known from the northern Gulf, but we did not see them in the St. Andrew Bay System during our study. Along the northern Gulf, *Littoridina crosseana*

(Pilsbry, 1910) appears to be restricted to the coastal areas of Texas and Mexico (Hershler and Thompson 1992). The ovoviviparous *Pyrgophorus platyrachis* occurs most commonly in vegetated, low salinity, tidal marsh ponds; brackish water drainage ditches; and canals. It has been reported from Florida (Thompson 1965) westward to Mississippi and Louisiana (Garrett and Dundee 1979, Heard 1982). This species should be present in the St. Andrew Bay System, but we have not yet visited habitats expected to be typical for this species. Hershler and Thompson (1992) considered the taxonomic status of most of the nominal species of *Pyrgophorus* as uncertain. They included *P. platyrachis*, which is closely related to or possibly an ecophenotype of *Pyrgophorus coronatus* (Pfeiffer, 1840). Subspecies of *P. coronatus* have been reported to occur widely throughout the Caribbean Region (Hershler and Thompson 1992). There also remains the possibility that *Probythinella protera sensu* Solem, 1961, a taxon accepted by Hershler (1996), may be present in the headwaters of the St. Andrew Bay System. *Probythinella protera* was originally described from what appeared to be fossil shells taken from Pliocene sediments near Tampa Bay (Pilsbry 1953). Solem (1961) reported a large extant population from Lake Pontchartrain, Louisiana. Morrison (1965) described a new genus for *Vioscalba louisianae* Morrison, 1965 from Louisiana coastal waters (Lake Pontchartrain). The species was later reported to be a common resident of Texas bays by Andrews (1971, 1977). Heard (1982) considered *Vioscalba* Morrison, 1965 a junior synonym of *Probythinella*. He also suggested that *P. protera* and *P. louisianae* were conspecific or that both were ecophenotypic forms of *Probythinella lacustris* (Baker, 1928), a nominal species previously known from the fresh waters of the Mississippi River Drainage System. Notwithstanding, Heard (1982) tentatively chose to recognize *P. louisianae* and the possibly extinct *P. protera* as distinct species. In a recent review of the genus, Hershler (1996) recognized only two extant North American species, *Probythinella emarginata* (Kuster, 1852), previously known as *P. lacustris*, and *P. protea*, previously known as *P. louisianae*. We follow his classification here.

Species of *Probythinella* have a wide distribution. *Probythinella emarginata* is now known from the North American drainages of the Mississippi and Mackenzie rivers, the Great Lakes, and Hudson Bay. Extant populations of *P. protera sensu* Solem (1961) and Hershler (1996) occur in the low salinity coastal habitats along the northern Gulf from Texas to Mobile Bay. Regardless of the taxonomic status of the nominal species of

*Probythinella*, we expect extant populations of species in the genus to occur in some of the oligohaline and tidal freshwater reaches of estuaries and river mouths between Mobile and Tampa Bays. The Mill Bayou (FL Hwy 390) and Deer Point Reservoir collecting sites appeared to be especially suitable habitats for species of *Probythinella*; however, no such snail or empty shell was observed at either site during our study.

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## Crustacea of the Cayman Islands, British West Indies. I. Records of Mysids from Shallow Water Non-Reef Habitats

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# CRUSTACEA OF THE CAYMAN ISLANDS, BRITISH WEST INDIES. I. RECORDS OF MYSIDS FROM SHALLOW WATER NON-REEF HABITATS

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**ABSTRACT** A single species of mysid *Siriella chierchiae* has been previously reported from the Cayman Islands. However, between May 1995 and August 1999, 20 species of mysids were collected from shallow water non-reef habitats surrounding Grand Cayman and Little Cayman Islands. Of the species collected, one species *Anchialina typica* has a cosmopolitan distribution in tropical and subtropical seas. Thirteen species (*Amathimysis cherados*, *A. gibba*, *Bowmaniella johnsoni*, *Dioptrornysis paucispinosa*, *Heteromysis bermudensis*, *H. mayana*, *Mysidium columbiae*, *M. gracile*, *M. integrum*, *Mysidopsis bispinulata*, *M. brattstromi*, *Parvinymis bahamensis*, *Siriella chierchiae*) are found widely distributed throughout the subtropical and tropical waters of the Northwest Atlantic. Four species (*Heteromysis coralina*, *Mysidopsis mathewsoni*, *Siriella chessi*, *S. macrophthalma*) previously known only from their type localities are reported, and two undescribed species of *Heteromysis*, one from Little Cayman Island, and one from Grand Cayman Island, are recognized.

## INTRODUCTION

The Cayman Islands, located south of Cuba and west of Jamaica, consist of 3 islands: Grand Cayman, Cayman Brac, and Little Cayman. Grand Cayman, the largest of the islands with an area of about 200 km<sup>2</sup>, is 300 km from both Cuba and Jamaica. Cayman Brac (38 km<sup>2</sup>) and Little Cayman (28 km<sup>2</sup>) are only 7 km apart and lie about 130 km northwest of Grand Cayman (Davies and Brunt 1994).

With the exception of the descriptions of a fresh water isopod (Bowman and Franz 1982), descriptions and reports of species of copepods from Grand Cayman (Wells 1980; Yeatman 1984; Suarez-Morales et al. 1999), and a few reports of common semi-terrestrial and shallow water marine taxa (Sefton 1976; Hounscome 1980, 1994; Potts 1980a, b; Britton et al. 1982; Logan 1994; Roberts 1994), the crustacean fauna of the Cayman Islands is poorly known. To date, the only published record of a mysid from these islands is that of *Siriella chierchiae* Coifmann, 1937, reported by Brattegard (1970b) from Grand Cayman. The purpose of this report is to document the marine mysid fauna from the various shallow water non-reef habitats of Grand Cayman Island and Little Cayman Island. Cayman Brac is not included because we did not have an opportunity to study the mysid fauna of that island.

## MATERIALS AND METHODS

Collections of mysids were made in the shallow ( $\leq 3$  m), back reef habitats of Grand Cayman Island and Little Cayman Island (Figure 1) between May 1995 and August 1999. Collecting methods included the use of fine mesh kicknets (mesh size 0.5 and 1.0 mm), an epibenthic sled (0.33 mm), a plankton net (mouth diameter 33 cm, 0.33 mm mesh size), a yabby pump, and a light trap. Algal-sponge-rock substrata were gently washed in a weak formalin-seawater solution and specimens were captured on a 0.5mm sieve. Samples were preserved in 10% formalin-seawater. Measurements of total length of mysids were determined as the distance from the anterior dorsal margin of the carapace to the posterior margin of the telson, excluding spine-setae. Brood size was determined from counts of young removed from full marsupia of ovigerous females. Larval development was categorized into 3 phases according to Wittmann (1981): 1) embryonic—embryo spherical and surrounded by an egg membrane; 2) nauplioid—larva elongate, but enclosed in naupliar cuticle; 3) postnauplioid—all appendages and eyestalks free following molt of cuticle. Illustrations are original unless otherwise noted. Representative specimens of each species are deposited in the National Museum of Natural

History, Smithsonian Institution, Washington, DC, and the Gulf Coast Research Laboratory Museum.

## RESULTS

Eighteen described and two undescribed species of mysids were identified from more than 2600 specimens collected from shallow water marine non-reef habitats surrounding the islands of Grand Cayman and Little Cayman (Figure 1). These species represent three sub-families (Siriellinae, Gastrosaccinae, Mysinae) belonging to the family Mysidae. Synonymies, occurrence, distribution, ecological, and systematic notes are presented for each species. Lateral and dorsal views of a typical mysid are illustrated in Figure 2.

### Key to the Mysids of the Cayman Islands

1. Each eye with large, single-lensed accessory eye at dorsolateral border between cornea and eye-stalk (Figure 3A); telson cleft, with pair of long, plumose spine-setae at base of cleft (Figure 4A) ..... *Diopromysis paucispinosa*

Eyes normal, without accessory eye; telson entire, emarginate or cleft, if cleft, then without pair of long, plumose spine-setae at base (Figures 4B, E, I) ..... 2

2. Exopod of uropod divided by distal suture (Figure 3B); telson entire, narrowly lanceolate, apex with pair of long, stout spine-setae laterally, 3 small spine-setae and pair of plumose spine-setae medially (Figures 4B–D) (*Siriella*) ..... 3

Exopod of uropod undivided (Figures 3F–J); telson entire, emarginate or cleft, if entire, apex without plumose spine-setae ..... 5

3. Carpus of endopod of 8th thoracic limb shorter than propodus (Figure 3C); basal plate of exopod of thoracic limbs 3–6 with small tooth on outer distal corner (Figure 3E) ..... 4

Carpus of endopod of 8th thoracic limb equal to propodus in length (Figure 3D); basal plates of exopod of limbs 3–6 without tooth (Figure 3D) ..... *Siriella macrophthalma*

4. Posterior 2/3 of telson armed with row of unequal lateral spine-setae, larger ones separated by groups of 2–6 smaller ones (Figure 4C) ..... *Siriella chierchia*

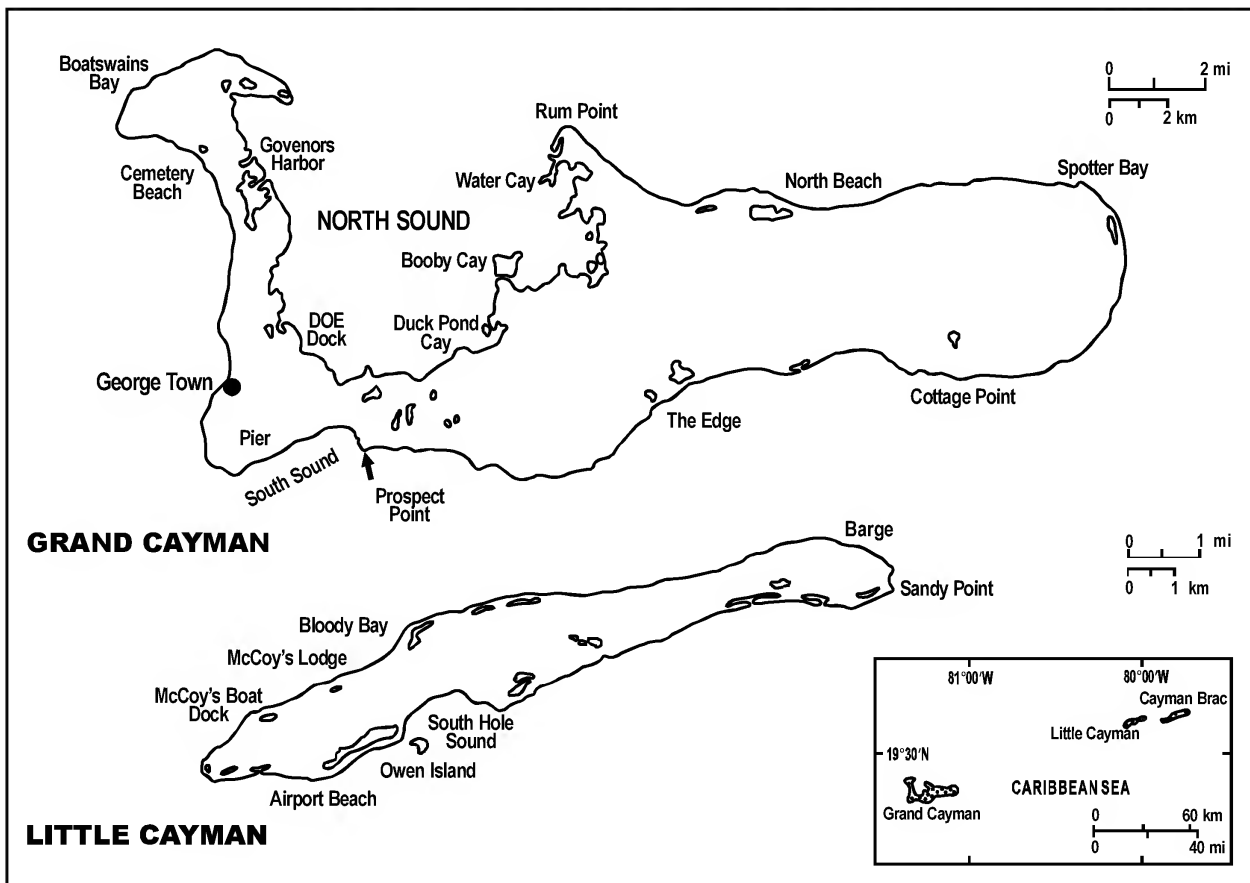


Figure 1. Map showing locations of collecting sites in water surrounding Grand Cayman Island and Little Cayman Island, British West Indies.

- Posterior 2/3 of telson armed with row of subequal lateral spine-setae (Figure 4D) ..... *Siriella chessi*
5. Lateral margin of exopod of uropod armed with strong spine-setae (Figure 3F) (telson cleft) ..... 6
- Lateral margin of exopod of uropod armed with slender spine-setae (telson entire, emarginate, or cleft) ..... 7
6. Each apical lobe of telson armed with one large spine-seta, lateral margins with >15 spine-setae (Figure 4E) ..... *Anchialina typica*
- Each apical lobe of telson armed with 2 large spine-setae, lateral margins with <10 spine-setae (Figure 4F) ..... *Bowmaniella johnsoni*
7. Width of telson base less than twice width of telson apex (less than posterior half of lateral margins of telson armed with spine-setae) (Figures 4G–I) (*Mysidium*)..... 8
- Width of telson base 3–5 times width of telson apex (lateral margins of telson without spine-setae or partially or completely armed with spine-setae) (Figures 4J–T) ..... 10
8. Apex of telson cleft (Figure 4G); antennal scale 7–11 times as long as wide ..... *Mysidium columbiae*
- Apex of telson transversely rounded or emarginate (Figures 4H, I); antennal scale 4–6 times as long as wide ..... 9
9. Apex of telson transversely rounded, lateral margins straight or slightly convex (Figure 4H) ..... *Mysidium integrum*

- Apex of telson emarginate, lateral margins slightly concave (Figure 4I) ..... *Mysidium gracile*
10. Telson with no lateral spine-setae (Figures 4J–L) .. 11
- Telson with lateral spine-setae (Figures 4M, T) .. 13
11. Posterior end of telson emarginate, each apical lobe with one short spine-seta (Figure 4J) ..... *Mysidopsis bispinulata*
- Posterior end of telson entire, apex with median pair of long spine-setae and shorter adjacent lateral pair (Figures 4K, L) (*Amathimysis*) ..... 12
12. Antennal scale with distolateral tooth extending beyond apex of scale, scale without distal suture (Figure 4K) ..... *Amathimysis gibba*
- Antennal scale with distolateral tooth not reaching apex of scale, scale with distal suture (Figure 4L) ..... *Amathimysis cherados*
13. Apex of telson emarginate or cleft (Figures 4M–R) ..... 14
- Apex of telson entire, not emarginate or cleft (Figures 4S–T) ..... 19
14. Apex of telson broadly emarginate, armed with 1–5 spinules near midline, each apical lobe with 1 short spine-seta (Figure 4M) ..... *Parvimysis bahamensis*
- Apex of telson deeply cleft, cleft armed with 6 or more spinules, each apical lobe with a pair of spine-setae (Figures 4N–R) (*Heteromysis*) ..... 15

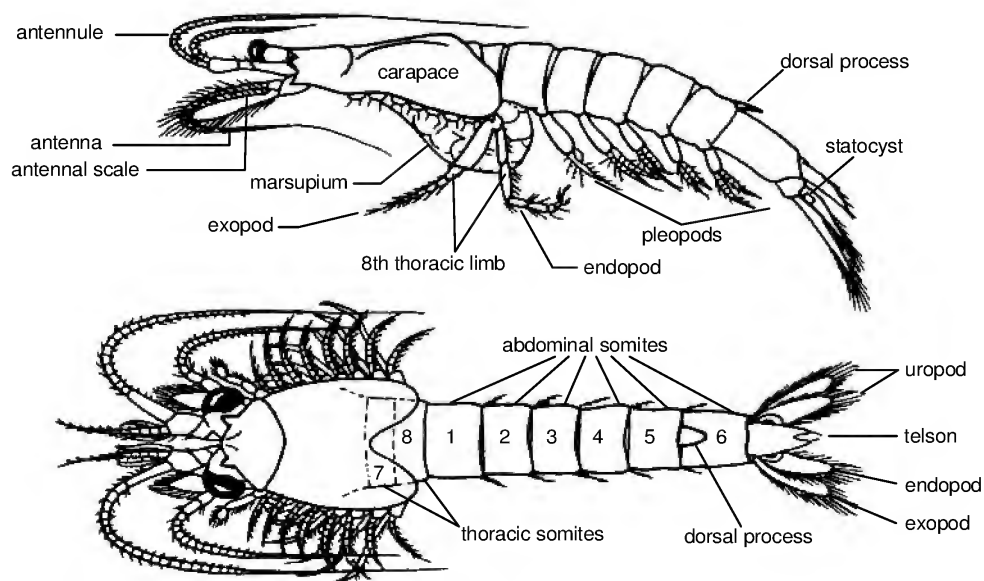


Figure 2. Lateral and dorsal views of a typical mysid (modified from Stuck et al. 1979a).



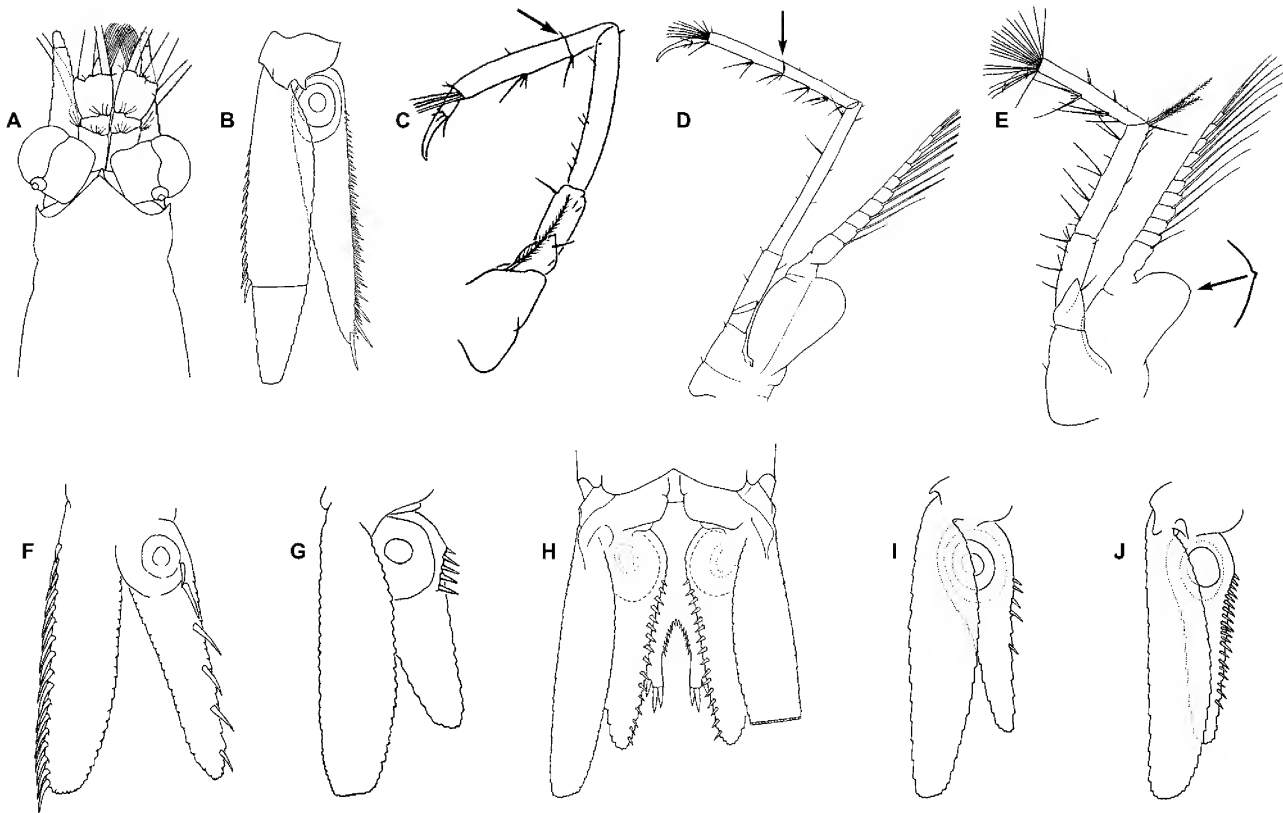


Figure 3. A. *Diopromysis paucispinosa*, dorsal view of anterior end (from Brattegard 1969: Figure 21A). B. *Siriella chierchia*, uropod (from Tattersall 1951: Figure 16b). C. *Siriella chessi*, thoracic endopod 8 (from Murano 1986: Figure 3H). D. *Siriella macrophthalma*, thoracic endopod 8 (from Murano 1986: Figure 1F). E. *Siriella chessi*, thoracic endopod 3 (from Murano 1986: Figure 3G). F. *Bowmaniella brasiliensis*, uropod (from Stuck et al. 1979a: Figure 4C). G. *Heteromysis coralina*, uropod (from Modlin 1987b: Figure 2J). H. *Heteromysis bermudensis*, telson and uropods (from Brattegard 1973: Figure 20E). I. *Mysidopsis mathewsoni*, uropod (from Brattegard 1969: Figure 7F). J. *Mysidopsis brattstroemi*, uropod, (from Brattegard 1969: Figure 11E).

15. Margins of telsonal cleft with spinules along entire length (Figures 4N, O) .....

Margins of telsonal cleft without spinules along entire length, spinules usually located only in anterior half (Figures 4P–R) .....

16. Entire length of lateral margins of telson armed with spine-setae (Figure 4N) .....

..... *Heteromysis* sp. A

Only posterior 1/2–3/4 of lateral margins of telson armed with spine-setae (Figure 4O) .....

..... *Heteromysis mayana*

17. Endopod of uropod with 2–5 spine-setae medially (Figure 3G) .....

..... *Heteromysis coralina*

Endopod of uropod with 10–17 spine-setae medially (Figure 3H) .....

..... 18

18. Telsonal cleft with 6–10 spinules (Figure 4Q) .....

..... *Heteromysis* sp. B

Telsonal cleft with 11–17 spinules (Figure 4R) .....

..... *Heteromysis bermudensis*

19. Apex of telson with innermost pair of spine-setae almost twice as long as adjacent spine-setae (Figure 4S); endopod of uropod with 4–5 spine-setae medially (Figure 3I).....

*Mysidopsis mathewsoni*

Apex of telson with innermost pair of spine-setae only slightly longer than adjacent spine-setae (Figure 4T); endopod of uropod with 10–20 spine-setae medially (Figure 3J) .....

*Mysidopsis brattstroemi*

#### *Mysidopsis brattstroemi*

#### Order Mysida

#### Family Mysidae

#### Subfamily Siriellinae

#### *Siriella chessi* Murano, 1986

*Siriella chessi*.—Murano 1986:137, Figures 3–4.

**Material.** GRAND CAYMAN ISLAND: (males-0, ovigerous females-0, immature females-8, juveniles-14), South Sound (Pier), sand/seagrass, 1–2 m, kicknet,

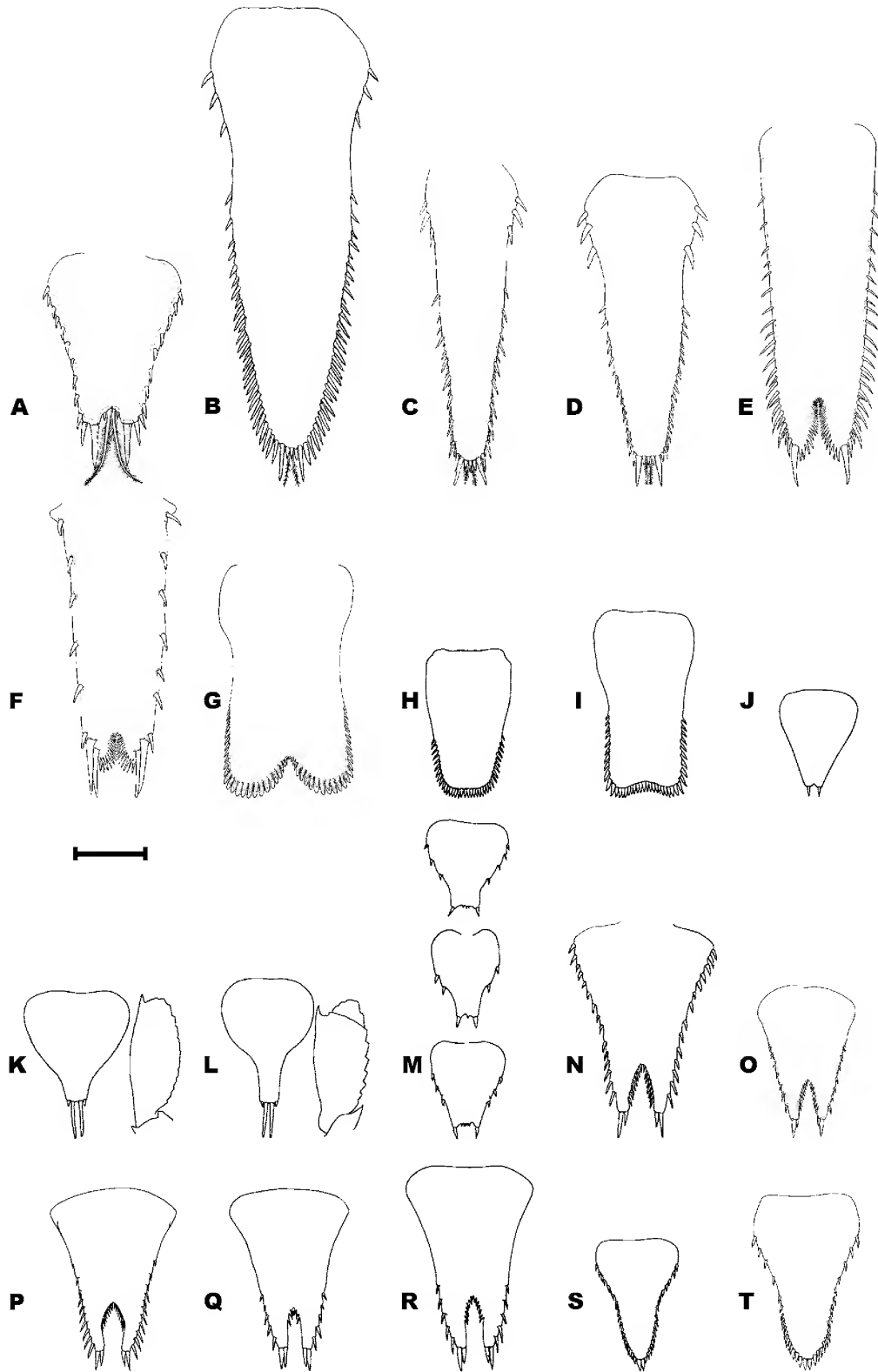


Figure 4. A. *Diopromysis paucispinosa*, telson. B. *Siriella macrophthalma*, telson. C. *Siriella chierchiaie*, telson. D. *Siriella chessi*, telson. E. *Anchialina typica*, telson. F. *Bowmaniella johnsoni*, telson. G. *Mysidium columbiae*, telson. H. *Mysidium integrum*, telson. I. *Mysidium gracile*, telson. J. *Mysidopsis bispinulata*, telson. K. *Amathimysis gibba*, telson and antennal scale. L. *Amathimysis cherados*, telson and antennal scale. M. *Parvimysis bahamensis*, telson. N. *Heteromysis* sp. A, telson. O. *Heteromysis mayana*, telson. P. *Heteromysis coralina*, telson. Q. *Heteromysis* sp. B, telson. R. *Heteromysis bermudensis*, telson. S. *Mysidopsis mathewsoni*, telson. T. *Mysidopsis brattstromi*, telson. Scale = 0.2 mm.

rock washings, light trap, 15 Jun 1997.—(3-0-1-0), South Sound Prospect Point, 1.0–1.5 m, rock washings, 17 May 1998.—(4-0-0-0), same station, rock washings, 12 Aug 1999.—(9-7-5-0), Edge, sand/seagrass, 1–2 m, rock washings, 30 Aug 1996.—(2-5-2-6), same station, kicknet, plankton net, epibenthic sled, night tows, 14 May 1998.—(1-0-0-5), same station, rock washings, 21 May 1998.—(10-17-0-2), Cottage Point, 1–2 m, rock/algal washings, 23 May 1998.—(1-0-0-4), same station, rock/algal washings, 13 Aug 1999.—(1-0-0-0), Spotter Bay, 1.0–1.5 m, rock/algal washings, 16 May 1998.—(5-2-8-1), North Beach, sand/grass, 1.0–1.5 m, rock washings, 1 Sep 1996.—(4-3-1-3), same station, kicknet, epibenthic sled, yabby pump, 12 May 1998.—(0-1-0-0), North Sound, off Duck Pond Cay, grass, 1.5 m, plankton net, night, 13 May 1998. LITTLE CAYMAN ISLAND: (2-2-1-0), South Hole Sound, Head o' the Bay, sand, 1 m, light trap, 19 May 1995.—(4-5-3-1), South Hole Sound, middle, 1–2 m, plankton net, night, 23 May 1995.—(5-1-6-2), Barge, sand/seagrass, 1.0–1.5 m, kicknet, 6 Jun 1997.

**Type Locality.** St. Croix, Virgin Islands.

**Distribution.** Virgin Islands (Murano 1986); Cayman Islands (present study).

**Ecological remarks.** This species was generally taken from rock/algal washings during the day and in the water column at night. It probably undergoes vertical migration as do several other oceanic and neritic species of *Siriella* (Ii 1964).

Ovigerous females ranged from 5.1–6.3 mm in length; brood pouches contained 4–8 larvae. Diameter of embryonic phase 0.36–0.40 mm; longest postnauplioid phase 1.2 mm.

**Systematic remarks.** The collection of *Siriella chessi* in the waters surrounding Grand Cayman and Little Cayman Islands constitutes only the second time it has been reported and the first record for females. Our specimens exhibited greater morphological variation than reported in the original description of Murano (1986). The uropodal endopod spine-setae of mature specimens ranged from 13–39 (usually 18–25) rather than 37, and the outer margin of the proximal article of the uropodal exopod was armed with 5–8 spine-setae, rather than 8. Murano found a small tooth on the outer distal corner of the basal plate of the exopods on thoracic limbs 3–6, but not limbs 7 or 8. Occasionally, our specimens exhibited this tooth on thoracic limbs 3–8. *Siriella chessi* is morphologically similar to *S. chierchiae*, a species that is found throughout the Caribbean Sea and coastal waters of the western Atlantic to Brazil (Escobar-Briones and Soto 1988). However, setation of the telson, male pleopods 3 and 4, and penal lobes of our specimens agreed

well with the description and illustrations of Murano as compared to those for *S. chierchiae* (Coifmann 1937; W. M. Tattersall 1937, 1951; Brattegard 1970a, b). In addition, the uropodal endopod spine-setae of *S. chierchiae* number 45 or more and the outer margin of the proximal article of the uropodal exopod has 10–13 spine-setae.

### *Siriella chierchiae* Coifmann, 1937

*Siriella chierchiae*.—Coifmann 1937:3, Figure 1.—W. M. Tattersall 1951:66, Figures 15–16.—Brattegard 1970a:2, Figure 1.—Brattegard 1970b:116, Figure 2.—Brattegard 1973:9.—Brattegard 1974a:51.—Brattegard 1974b:91.—Brattegard 1975:109.—Băcescu and Ortiz 1984:16, Figure 1a.—Modlin 1984:279.—Modlin 1987a:109.—Escobar-Briones and Soto 1988:640.—Markham et al. 1990:411.

*Siriella occidentalis*—W. M. Tattersall 1937:6, Figures 3–4.

**Material.** GRAND CAYMAN ISLAND: (males-0, ovigerous females-0, immature females-4, juveniles-0), South Sound (Pier), sand/seagrass, 1–2 m, plankton net, night, 30 Aug 1996.—(0-1-0-0), Cottage Point, 1–2 m, rock washings, 23 May 1998.—(0-1-0-0), North Sound, off Governor's Harbor (19°23.20'N, 81°20.78'W), sand/seagrass, 2–3 m, epibenthic sled, night, 11 Jun 1997.—(13-6-12-1), North Sound, off Duck Pond Cay, grass, 1.5 m, plankton net, night, 13 May 1998.—(0-0-6-1), North Sound, off Booby Cay, seagrass, 3 m, plankton, night, 13 May 1998.—(1-1-2-0), North Sound, east (19°20.00'N, 81°21.66'W), seagrass, 2 m, plankton net, night, 13 Aug 1999. LITTLE CAYMAN ISLAND: (0-1-1-1), Bloody Bay, McCoy's dock, sand, 5 m, light trap, night, 27 May 1995.—(0-0-1-0), Bloody Bay, McCoy's Lodge, intertidal rocks, rock washings, 27 May 1995.

**Type Locality.** Pernambuco-Rio de Janeiro, Brazil.

**Distribution.** Caribbean Sea, coastal waters of western Atlantic to Brazil (Coifmann, 1937; W. M. Tattersall 1951; Brattegard 1970a, b, 1973, 1974a, b, 1975; Băcescu and Ortiz 1984; Modlin 1987a; Markham et al. 1990); Key West, Florida (W. M. Tattersall 1951); Cayman Islands (present study); Gulf of Mexico (Modlin 1984; Escobar-Briones and Soto 1988).

**Ecological remarks.** Like *S. chessi*, this species appears to be associated with benthic substrata during the day and migrates into the water column at night in the shallow waters of the Cayman Islands. Brattegard (1970a, b, 1973, 1974a, b) noted similar activities from coastal waters of the Caribbean, although Modlin (1984) recorded this species 160 km offshore in the Gulf of Mexico.

Ovigerous females ranged from 7.7–8.6 mm in length and carried 5–13 larvae per brood. Embryonic phase diameter 0.38–0.40 mm; longest postnauplioid phase 1.8 mm.

**Systematic remarks.** See remarks for *S. chessi*.

***Siriella macrophthalma* Murano, 1986**

*Siriella macrophthalma*.—Murano 1986:133, Figures 1, 2.

**Material.** GRAND CAYMAN ISLAND: (males-3, ovigerous females-1, immature females-7, juveniles-0), The Edge, 1.0–1.5 m, kick net, plankton net, epibenthic sled, night, 14 May 1998.

**Type Locality.** St. Croix, Virgin Islands.

**Distribution.** Virgin Islands (Murano 1986); Grand Cayman Island (present study).

**Ecological remarks.** Specimens were collected at night in the water column over sand bottoms and seagrass beds at only one back reef station on Grand Cayman Island.

The only ovigerous female collected was 9.6 mm long and harbored embryonic phase larvae that were 0.42 mm in diameter.

**Systematic remarks.** This species is very similar morphologically to *S. mexicana* Brattegard, 1970. Murano (1986) used subtle differences in morphology of the male, including the setation of pleopods 3 and 4, penial lobes, and lobe of antennular peduncle to distinguish *S. macrophthalma* from *S. mexicana*. When compared to the descriptions of these two species, the single adult male collected had overlapping as well as minor differences in these features. Until additional specimens of *S. mexicana* and *S. macrophthalma* and the material from the Caymans can be compared, the specific status of *S. macrophthalma* remains uncertain.

**Subfamily Gastrosaccinae**

***Anchialina typica* (Kroyer, 1861)**

*Anchialus typicus*.—Kroyer 1861:53, Plate 2, Figure 7a–l.—G.O. Sars 1885:193, Plate 34, Figures 4–24.

*Anchialina typica*.—Hansen 1910: 52, Plate 7, Figure 2a–k.—Nouvel, 1943:70, Plate 4, Figures 109–110.—O.S. Tattersall 1955:89, Figure 15.—Ii 1964:188, Figures 48–49.—Brattegard 1970a:24, Figure 6.—Nouvel 1971:325, Figure 1.—Stuck et al. 1979a:227, Figures 2a, 3a, 4a, 5a.—Băcescu and Ortiz 1984:16, Figure 1b.

**Material.** GRAND CAYMAN ISLAND: (males-0, ovigerous females-1, immature females-1, juveniles-0),

North Sound, off Governor's Harbor (19°23.20'N, 81°20.78'W), sand/seagrass, 2–3 m, epibenthic sled, night, 11 Jun 1997.—(11-2-6-7), North Sound, off Duck Pond Cay, grass, 1.5 m, plankton net, night, 13 May 1998.—(41-9-248-0), North Sound, off Booby Cay, grass, 3 m, plankton net, epibenthic sled, night, 13 May 1998.—(14-3-0-3), North Sound, east (19°20.00'N, 81°21.66'W), grass, 2–3 m, epibenthic sled, night, 13 Aug 1999.—(1-0-1-0), Cemetery Beach, sand, 3 m, kicknet, 20 May 1998. LITTLE CAYMAN ISLAND: (0-1-0-0), Bloody Bay, McCoy's dock, sand, 5 m, light trap, 22 May 1995.

**Type Locality.** Tropical Atlantic, 14°N.

**Distribution.** Widely distributed in the tropical and sub-tropical regions of the Atlantic, Indian and Pacific oceans (W. M. Tattersall 1951; Ii 1964; Brattegard 1970a, 1973, 1975; Băcescu and Ortiz 1984); waters off Nova Scotia (Nouvel 1943); South Carolina (Wigley and Burns 1971); Gulf of Mexico (Hopkins 1966; Stuck et al. 1979 a, b; Modlin 1984; Price et al. 1986).

**Ecological remarks.** The presence of this widely known species in Caymanian waters was expected. Most specimens were collected with epibenthic sleds and plankton nets at night in depths of 2–3 m in North Sound, Grand Cayman Island. Tattersall (1951), Brattegard (1970a), and Modlin (1984) found this species primarily in the plankton, but the latter author noted small numbers associated with a variety of benthic substrata.

Ovigerous females ranged from 3.7–4.7 mm in length and carried 3–4 larvae per brood. Embryonic phase diameter 0.30–0.32 mm; longest postnauplioid phase 0.9 mm.

**Systematic remarks.** None.

***Bowmaniella johnsoni* (W.M. Tattersall, 1937)**

*Gastrosaccus johnsoni*.—W.M. Tattersall 1937:9, Figures 5–7.—Tattersall 1951:93, Figures 26–28.

*Bowmaniella johnsoni*.—Băcescu 1968b:356.—Brattegard 1975:109.

**Material.** GRAND CAYMAN ISLAND: (males-8, ovigerous females-3, immature females-0, juveniles-0), Rum Point, sand, 1.0–1.5 m, kicknet, 1 Sep 1996.—(2-8-3-0), same station, kicknet, epibenthic sled, 12 May 1998.—(5-1-1-0), Water Cay, sand, 1.5 m, kicknet, 18 May 1998.—(31-19-5-0), North Sound (19°23.20'N, 81°20.78'W), seagrass/sand, 2–3 m, plankton net, night, 13 Aug 1999.—(1-0-1-9), Cemetery Beach, sand, 3 m, kicknet, 20 May 1998. LITTLE CAYMAN ISLAND: (75-52-26-31), South Hole Sound, middle, 1–2 m, plankton net, night, 19 May 1995.—(0-1-0-6), South Hole Sound, west end, sand, 1–2 m epibenthic sled, night, 19

May 1995.—(0-2-0-0), South Hole Sound, west end, sand, 1.5 m, kicknet, 19 May 1995.

**Type Locality.** Puerto Rico.

**Distribution.** Puerto Rico, Virgin Islands (W.M. Tattersall 1937); US east coast (W.M. Tattersall 1951); Lesser Antilles (Brattegard 1975); Cayman Islands (present study).

**Ecological remarks.** This species was collected over sand bottoms with kicknets and epibenthic sleds during the day and was found in the plankton at night. It was reported as “very abundant” at night in coastal waters of the Virgin Islands and Puerto Rico (Tattersall 1937).

Ovigerous females ranged from 6.1–8.9 mm long and carried 5–15 larvae per brood. Diameter of embryonic phase 0.36–0.40 mm; longest postnauplioid phase 1.4 mm.

**Systematic remarks.** This species appears to be a senior synonym of *Bowmaniella bacescui* Brattegard, 1970. Both species represent the ultimate male stage; the penultimate stage is undescribed. The results of these and other taxonomic problems associated with the genus *Bowmaniella* are the subject of a future publication.

#### Subfamily Mysinae

##### Tribe Erythropini

#### *Amathimysis cherados* Brattegard, 1974

*Amathimysis cherados*.—Brattegard 1974a:56, Figure 1 A–D.

**Material.** GRAND CAYMAN ISLAND: (Males-3, ovigerous females-2, immature females-6, juveniles-0), The Edge, rock washings, 1–2 m, 30 Aug 1996.—(0-1-0-0), same station, rock washings, 11 May 1998.—(1-1-0-0), same station, rock washings, 21 May 1998.—(2-0-2-1), Cottage Point, rock washings, 1–2 m, 23 May 1998.—(1-3-0-0), North Beach, rock washings, 1–2 m, 1 Sep 1996.—(0-2-0-1), North Beach, seagrass/sand, kicknet, yabby pump, 1.0–1.5 m, 12 May 1998.—(3-1-1-0), Water Cay, sand, 1.5 m, kicknet, 18 May 1998.—(7-1-0-0), North Sound, (19°23.20'N, 81°20.78'W), seagrass/sand, 2–3 m, plankton net, night, 13 Aug 1999. LITTLE CAYMAN ISLAND: (0-1-0-0), Owen Island, west end, 1.0–1.5 m, rock/algal washings, 19 May 1995.—(0-0-1-0), Sandy Point, 1.0–1.5 m, rock/algal washings, 23 May 1995.

**Type Locality.** Burucuca Bay, Colombia.

**Distribution.** Caribbean coasts of Colombia (Brattegard 1974a) and Panama (Brattegard 1974b); Aruba (Brattegard 1975); Grand Cayman (present study).

**Ecological remarks.** This species was collected from a variety of habitats including rock/algal debris,

sand/seagrass, and sand. Other investigators have obtained specimens from muddy sand/seagrass beds, green algal/seagrass bottoms, algal turf on hard coral, and sand/mud with organic debris and algae (Brattegard 1974a, b, 1975; Modlin 1987). *Amathimysis cherados* appears to remain closely associated with benthic substrata both day and night.

Ovigerous females ranged from 1.9–2.6 mm in length. Diameter of embryonic phase larva 0.28 mm; longest postnauplioid phase 0.6 mm.

**Systematic remarks.** This species is similar to *Amathimysis gibba*, but can be distinguished by the distolateral spine on the antennal scale being subterminal and not extending beyond the tip of the scale, which has a distal segment. Also, the posterior part of the telson narrows abruptly and is much more constricted than in *A. gibba*.

This first record of *A. cherados* from the northern Caribbean agrees with the brief original description, with the exception of the size of the “humps” on the midline of the carapace. Brattegard (1974a) describes the carapace as having a well-defined protuberance anterior to the cervical sulcus and a smaller one behind it. For our material, both protuberances are smaller than the ones found in Brattegard’s illustration (Figure 1A) of a male. In addition, Cayman males exhibit larger “humps” than females. Examination of male and female paratypes of *A. cherados* showed this same sexual dimorphism.

#### *Amathimysis gibba* Brattegard, 1969

*Amathimysis gibba*.—Brattegard 1969:28, Figures 4–5.—Brattegard 1974a:52, Figure 1E–F.

**Material.** GRAND CAYMAN ISLAND: (males-4, ovigerous females-7, immature females-0, juveniles-0), Water Cay, sand, 1.5 m, kicknet, 18 May 1998.—(26-20-3-1), North Sound (19°23.20'N, 81°20.78'W), seagrass/sand, 2–3 m, plankton net, night, 13 Aug 1999.

**Type Locality.** Sands Key, Florida Keys, Florida.

**Distribution.** Bahamas, southern Florida (Brattegard 1969); Gulf of Mexico (Modlin 1984); Grand Cayman Island (present study); Belize (Modlin 1987a); Caribbean coasts of Colombia (Brattegard 1974a) and Panama (Brattegard 1974b); Puerto Rico (Brattegard 1970b).

**Ecological remarks.** This widely distributed Caribbean species was collected from sand or sand/seagrass habitats on Grand Cayman Island. Other investigators found specimens in similar habitats (Brattegard 1969, 1970b, 1973, 1974a, b; Modlin 1987), although Modlin (1984) collected one individual from a scaly soft coral in Belize.

Ovigerous females ranged from 2.1–3.2 mm long; embryonic phase larvae were 0.28–0.32 mm in diameter.

**Systematic remarks.** This species is distinguished from *A. cherados* by having the distolateral spine located terminally on the antennal scale (extending beyond scale), which has no distal segment. The posterior part of the telson does not narrow as abruptly and is less constricted than in *A. cherados*.

Our material agreed with Brattegard's (1969) original description, with minor exceptions. The uropodal endopods of all Cayman specimens were longer than, rather than equal to, the exopods. For Brattegard's specimens, the antennal scale was 3.5 times as long as wide. We found sexual dimorphism for this proportion: mature males and females averaged 3.6 (range 3.3–4.2) and 3.1 (2.8–3.5), respectively.

### Tribe Leptomysini

#### *Diopromysis paucispinosa* Brattegard, 1969

*Diopromysis paucispinosa*.—Brattegard 1969:69, Figures 21–22.

**Material.** GRAND CAYMAN ISLAND: (males-1, ovigerous females-0, immature females-0, juveniles-0), South Sound (Pier), 1–2 m, plankton net, night, 30 Aug 1996.—(0-0-1-0), The Edge, sand, 1.0–1.5 m, kicknet, night, 14 May 1998.—(0-1-1-0), Spotter Bay, sand, 1 m, kicknet, 16 May 1998.—(1-0-0-0), North Beach, seagrass/sand, 1.0–1.5 m, kicknet, epibenthic sled, 12 May 1998.—(1-0-0-0), North Sound (19°23.20'N, 81°20.78'W), seagrass/sand, 2–3 m, epibenthic sled, night, 11 Jun 1997.—(1-0-2-0), same station, plankton net, night, 13 Aug 1999.

**Type Locality.** Andros, Bahamas.

**Distribution.** Bahamas (Brattegard 1969); Belize (Modlin 1987a); Grand Cayman Island (present study).

**Ecological remarks.** Specimens of this rare species were collected with plankton nets, kicknets, and epibenthic sleds from a number of sand/seagrass habitats of Grand Cayman Island. Brattegard (1969) collected *Diopromysis paucispinosa* from sand and sand/algal bottoms and Modlin (1987) found them associated with coral rubble, hard corals, and algal turf covering dead corals.

The only ovigerous female collected was 4.4 mm long.

**Systematic remarks.** This species is easily distinguished from other Cayman Island mysids by its large accessory eye located at the postero-dorsal border between the cornea and the eyestalk. In addition, a pair of long, plumose spine-setae is present in its telsonal cleft.

Slight morphological differences exist between the Cayman material and the original description of Brattegard (1969). He reported 6 plumose spine-setae on the distal article of the antennal scale, whereas our specimens have 5 plumose spine-setae. The ratio of the telson length to the length of the sixth abdominal segment in Brattegard's description was 0.9. It ranged from 0.83–0.85 in our specimens.

#### *Mysidopsis bispinulata* Brattegard, 1974

*Mysidopsis* sp. A.—Brattegard 1973:41, Figure 16.

*Mysidopsis bispinulata*.—Brattegard 1974a:58, Figure 3.

**Materials.** GRAND CAYMAN ISLAND: (males-1, ovigerous females-2, immature females-0, juveniles-0), South Sound (Pier), sand/seagrass, 1.0–2.0 m, kicknet, 15 Jun 1997.—(3-6-0-0), The Edge, sand/seagrass, 1.0–2.0 m, kicknet, 12 May 1998.—(15-26-22-6), Rum Point, sand/seagrass, 1.0–1.5 m, plankton net, night, 1 Sep 1996.—(9-3-11-5), same station, kicknet, epibenthic sled, night, 12 May 1998.—(14-17-5-8), Cemetery Beach, sand, 3 m, kicknet, 20 May 1998.

**Type Locality.** Bahia Concha, Colombia.

**Distribution.** Caribbean coasts of Colombia (Brattegard 1973, 1974a) and Panama (Brattegard 1974b); Grand Cayman (present study).

**Ecological remarks.** Specimens of this small species were obtained with a variety of nets from sand/seagrass or sandy substrata in the waters surrounding Grand Cayman Island. Brattegard (1973, 1974a, b) collected this species from gravel or sand bottoms with loose algae in depths of 3 m or less.

Ovigerous females ranged from 2.5–2.9 mm in length and carried 2–3 larvae. Diameter of embryonic phase 0.28–0.32 mm; longest postnauplioid phase 0.88 mm.

**Systematic remarks.** Based on our examination of specimens collected in other tropical western Atlantic locations, this species may be more widely distributed than records indicate. The shallow furcate telson, unarmed except for a pair of short apical spine-setae, immediately distinguishes this species from other mysids from the Cayman Islands.

#### *Mysidopsis brattstroemi* Brattegard, 1969

*Mysidopsis brattstroemi*.—Brattegard, 1969:40, Figures 10–11; Brattegard 1974b:94, Figure 2.

**Material.** LITTLE CAYMAN ISLAND: (1-1-0-0), Owen Island, west end, back reef sand flat, 1.5 m,

kicknet, 25 May 1995.—(11-20-1-0), Sandy Point, east end, sand, 1–2 m, kicknet, 23 May 1995.

**Type Locality.** Exumas, Bahamas.

**Distribution.** Bahama Islands and southern Florida (Brattegard 1969); Caribbean coast of Panama (Brattegard 1974b); Little Cayman Island (present study).

**Ecological remarks.** This species was taken at two stations with sand substrata on Little Cayman Island. Brattegard (1969, 1974b) collected specimens on sand and sand with seagrass, algae, or organic debris in depths of 2–15 m.

Ovigerous females ranged from 3.4–3.9 mm in length and brood pouches contained 3–6 larvae. Diameter embryonic phase 0.30–0.32 mm; longest postnauplioid phase 1.0 mm.

**Systematic remarks.** This species is superficially similar to *Mysidopsis eclipses* Brattegard, 1969, *M. mathewsoni* Brattegard, 1969, and *M. mortenseni* W.M. Tattersall, 1951, but is distinguished from these three species by the setation of the telson and inner uropod (9–20 spine-setae on inner uropod of *M. brattstroemi*; 8–9 for *M. eclipses*; 3–7 for *M. mathewsoni*; 16–31 for *M. mortenseni*).

The morphology of our specimens of *Mysidopsis brattstroemi* agrees with Brattegard's original description (1969) and subsequent illustrations (1974b), with minor differences. Brattegard reported pleopods 2–5 of mature males from the Bahamas with 6-articulate endopods and exopods (1969), whereas pleopod 4 of specimens from the Caribbean coast of Panama exhibited 7-articulate rami (1974b). Pleopods 2–5 of our mature males have 6-articulate rami. Brattegard (1969) found "a row of about 10–20" spine-setae along the inner margin of the uropodal endopod. One immature male from our collection has 9 spine-setae, all other specimens have 10–18.

#### *Mysidopsis mathewsoni* Brattegard, 1969

*Mysidopsis mathewsoni*.—Brattegard 1969:32, Figures 6–7.

**Material.** GRAND CAYMAN ISLAND: (males-1, ovigerous females-1, immature females-2, juveniles-0), The Edge, sand/seagrass, 1.0–1.5 m, kicknet, 12 May 1998.—(1-0-0-0), Spotter Bay, sand, 1.0–1.5 m, kicknet, 16 May 1998.—(1-1-0-0), North Sound (19°23.20'N, 81°20.78'W), sand/seagrass, 2–3 m, plankton net, night, 13 Aug 1999.—(2-1-0-1), Cemetery Beach, sand, 3 m, kicknet, 20 May 1998.

**Type Locality.** Eleuthera, Bahamas.

**Distribution.** Bahamas (Brattegard 1969); Grand Cayman Island (present study).

**Ecological remarks.** This is the second report of *Mysidopsis mathewsoni*, a rare species taken over sand bottoms and sand near patchy seagrass beds. Brattegard collected specimens in similar habitats in depths of 1–7 m.

Ovigerous females were 3.9–4.0 mm in length.

**Systematic remarks.** The morphology of our specimens agrees with the original description of Brattegard (1969), with two exceptions. He reported that the antennal scale was 3.5 times as long as broad, whereas this ratio is 4.1–4.3 for the Cayman material. The uropodal endopod of our specimens is armed with 2–5, usually 2–4, spine-setae near the statocyst rather than 3–7, usually 4–5, spine-setae for Brattegard's material from the Bahamas.

#### Tribe Mysini

##### *Mysidium columbiae* (Zimmer, 1915)

*Diamysis columbiae*.—Zimmer 1915:172, Figures 23–29.

*Mysidia columbiae*.—Zimmer 1918:26.

*Mysidium columbiae*.—W.M. Tattersall 1951:223.—Brattegard 1969:86, Figure 27.—Băcescu and Ortiz 1984:22, Figure 21.

**Material.** GRAND CAYMAN ISLAND: (males-2, ovigerous females-0, immature females-1, juveniles-0), South Sound, (Prospect Point), rubble/seagrass, 1–2 m, epibenthic sled, 17 May 1998.—(0-2-1-2), Edge, seagrass/sand, 1–2 m, kicknet, epibenthic sled, 12, 14 May 1998.—(0-0-1-0), North Beach, seagrass/sand, 1.0–1.5 m, kicknet, epibenthic sled, 12 May 1998.—(42-22-57-141), Rum Point, sand/seagrass, 1.0–1.5 m, kicknet, plankton net, night, 1 Sep 1996.—(22-38-3-0), same station, kicknet, epibenthic sled, night, 12 May 1998.—(0-0-1-0), North Sound, off Booby Cay, seagrass, 3 m, plankton net, night, 13 May 1998.—(1-2-25-0), Cemetery Beach, sand, 3.0 m, kicknet, 20 May 1998. LITTLE CAYMAN ISLAND: (1-5-0-0), South Hole Sound, middle, sand/seagrass, 1.5–2.0 m, epibenthic sled, night, 23 May 1995.—(0-0-1-0), South Hole Sound, west end, sand, 1–2 m, epibenthic sled, night, 19 May 1995.—(10-14-4-0), South Hole Sound, west end, sand, 1.5 m, kicknet, 19 May 1995.—(3-4-0-0), Sandy Point, east end, sand, 1–2 m, kicknet, 23 May 1995.—(0-5-2-0), Sandy Point, west end, 1.5 m, kicknet sweep near gorgonians, 23 May 1995.—(3-5-1-0), Airport Beach, seagrass, 1.0–1.5 m, kicknet, 20 May 1995.

**Type Locality.** Cartagena, Colombia.

**Distribution.** Coastal areas throughout the Caribbean Sea and southern Gulf of Mexico (Zimmer 1915;

W.M. Tattersall 1951; Steven 1961; Goodbody 1965; Emery 1968; Brattegard 1969, 1970b, 1973, 1974a, b, 1975; Băcescu and Ortiz 1984; Murano 1986; Modlin 1987a; Markham et al. 1990).

**Ecological remarks.** Most specimens occurred in epibenthic sled and plankton net collections from seagrass/sand or sand habitats. On occasion, large numbers were taken, indicating that aggregations were probably sampled. Other investigators found this species aggregating in a variety of near-shore habitats: coral reefs (Emery 1968; Brattegard 1973; Modlin 1987a, 1990), sand and sand/seagrass (Brattegard 1969, 1973, 1974b), coral rubble and algal turf (Modlin 1987a), mangroves (Steven 1961; Goodbody 1965; Brattegard 1975; Modlin 1987a, 1990, 1993), pelagic waters seaward of coral reefs (Modlin 1990), and in association with the sea urchin *Diadema antillarum* (Brattegard 1973, 1974a). The general biology of *Mysidium columbiae* and especially its aggregative behavior, (see Modlin 1990, 1993) has been the subject of several studies in the Caribbean.

Ovigerous females ranged from 4.7–7.6 mm in length and carried 4–10 larvae per brood. Embryonic phase diameter 0.34–0.48 mm; longest postnauplioid phase 1.7 mm.

**Systematic remarks.** This common species is easily distinguished from *Mysidium gracile* and *M. integrum* by its cleft telson, long narrow antennal scale, and 3-articulate exopod of male pleopod 4. Brattegard (1969) noted differences in the antennal scale, antennal peduncle, and male pleopod 4 when *M. columbiae* from the Bahamas and south Florida was compared with Zimmer's (1915) original description of specimens from the Caribbean coast of Colombia. The ratio of length to greatest width for the antennal scale of our mature specimens is variable (6.6–9.0) and intermediate between the ratios recorded by Zimmer (7.0) and Brattegard (9.0–11.0). The antennal peduncle of our specimens is fairly robust and resembles Zimmer's illustration (Figure 25) more closely than Figure 27D of Brattegard. Brattegard reported that the ratio of the length of article 1 of the exopod of male pleopod 4 when compared to articles 2 and 3 combined was greater than 2.0, not slightly less as recorded by Zimmer. The ratios for our specimens are generally less than 2.0 but range from 1.6–2.1.

#### *Mysidium gracile* (Dana, 1852)

*Macromysis gracilis*.—Dana 1852:653.—Dana 1855: Plate 43, Figures 5a–m.

*Mysidium gracile*.—Czerniavsky 1887:87.

*Mysidia gracilis*.—Zimmer 1918:24, Figures 33–44.

*Mysidium gracile*.—W.M. Tattersall 1951:223.—Brattegard 1969:80, Figure 25.

**Material.** GRAND CAYMAN ISLAND: ( males-12, ovigerous females-6, immature females-1, juveniles-0), North Sound (19°23.20'N, 81°20.78'W), seagrass/sand, 2–3 m, plankton net, night, 13 Aug 1999.—(2-1-6-3), Cemetery Beach, sand, 3 m, kicknet, 20 May 1998. LITTLE CAYMAN ISLAND: (2-0-0-0), South Hole Sound, west end, sand, 1–2 m, epibenthic sled, night, 19 May 1995.—(4-8-1-0), Owen Island, west end, back reef flat, sand, 1.5 m, kicknet, 25 May 1995.—(8-31-1-0), Sandy Point, east end, sand, 1–2 m, kicknet.

**Type Locality.** Rio de Janeiro, Brazil.

**Distribution.** Bermuda (Jander 1962); Florida Keys (Randall et al. 1964; Emery 1968; Brattegard 1969, 1970b); coastal areas throughout the Caribbean Sea (W.M. Tattersall 1951; Randall et al. 1964; Berrill 1968; Emery 1968; Brattegard 1974b, 1975); coast of Brazil (Dana 1852; Zimmer 1918; Costa 1964).

**Ecological remarks.** Specimens were collected from sand or patchy seagrass beds and sand. This species commonly forms aggregations in waters surrounding coral reefs throughout the Caribbean. Within the reef community, swarms may be associated with damselfish territories as well as *Diadema antillarum* (see Brattegard 1969; Twining et al. 2000). Relatively small numbers of *Mysidium gracile* were taken in the present study because the reef community proper was not sampled; only a few collections were made near patch reefs in the back reef habitat.

Ovigerous females were 4.7–6.3 mm in length and carried 4–6 larvae per brood. Diameter of embryonic phase 0.34–0.38 mm; longest postnauplioid phase 1.2 mm.

**Systematic remarks.** The specimens in our material agree with the description of Zimmer (1918) except for the length-width ratio of the antennal scale. The ratio for our specimens ranges from 5.0–6.0 as compared to about 4 for Zimmer. Brattegard's collection of *M. gracile* from South Florida (1969) differed from Zimmer's description and our specimens with respect to the articulation of the exopod of male pleopod 4 and the telson setation. Brattegard reported that articles 2, 3, and 4 of pleopod 4 of males were subequal, while specimens from Little Cayman have unequal articles (2 > 3 > 4) and agree with the proportions of Zimmer's drawing (Figure 43). The total number of spine-setae on the telson was similar for Zimmer's drawing (48), Brattegard's (46) and our material (34–56). However, Brattegard reported pointed spine-setae on the lateral margins and blunt spine-setae apically, while only pointed spine-setae are noted for Cayman



specimens and depicted by Zimmer. Additional collections of this species from throughout the Caribbean are needed before these morphological discrepancies can be resolved.

***Mysidium integrum* W.M. Tattersall, 1951**

*Mysidium integrum*.—W.M. Tattersall 1951:223, Figure 96.—Brattegard 1969:83, Figure 26.

**Material.** GRAND CAYMAN ISLAND: (males-2, ovigerous females-5, immature females-1, juveniles-1), South Sound (Prospect Point), rubble/seagrass, 1–2 m, epibenthic sled, 17 May 1998.—(4-4-2-5), The Edge, sand/seagrass, 1.0–1.5 m, kicknet, 12 May 1998.—(103-62-11-1), same station, *Acropora palmata*, 1.0–1.5 m, aquarium net, 11 May 1998.—(63-79-17-0), North Beach, sand depression, 2 m, aquarium net, 12 May 1998. LITTLE CAYMAN ISLAND: (1-0-0-0), Airport Beach, seagrass, 1.0–1.5 m, kicknet, 20 May 1995.—(0-1-0-0), Bloody Bay, McCoy's dock, sand, 5 m, light trap, 22 May 1995.

**Type Locality.** Cruz Bay, St. John, Virgin Islands.

**Distribution.** Coastal areas throughout the Caribbean Sea (W. M. Tattersall 1951; Brattegard 1969, 1970b, 1973, 1974a, b, 1975; Modlin 1987a); southern Florida (Emery 1968; Brattegard 1969); Gulf of Mexico (W.M. Tattersall 1951; Modlin 1984).

**Ecological remarks.** The largest numbers of this species were collected from swarms associated with patch reefs in back reef areas. Most previous reports of *Mysidium integrum* were from coral reef habitats (Emery 1968; Brattegard 1973; Modlin 1984, 1987), but it has been found over sand bottoms (Brattegard 1969, 1974a,b) and near mangroves (Brattegard 1975). At times, *M. integrum* may be associated with individual species of sponges, hard coral (Modlin 1984), gorgonians (Brattegard 1975, Modlin 1984), and sea anemones (Brattegard 1970b).

Ovigerous females ranged from 4.4–5.2 mm in length and carried 2–4 larvae per brood. Embryonic phase diameter 0.41–0.46 mm; longest postnauplioid phase 1.2 mm.

**Systematic remarks.** This species is similar to *Mysidium gracile* but is distinguished from it by the shape of the telson. The specimens in our material differ somewhat from the descriptions of W.M. Tattersall (1951) and Brattegard (1969, 1970b). With respect to male pleopod 4, our specimens are more similar to the description and illustration of Brattegard (1969, Figure 26D) than those of Tattersall (see Brattegard 1969 for discussion). Antennal scales of mature Cayman specimens

generally have a length/width ratio of about 5 but range from 4.2–5.7, as compared to 4.6–5.0 for Tattersall and Brattegard. All telson spine-setae were depicted as sharply pointed in previous descriptions; occasionally, Cayman specimens have pointed lateral spine-setae and blunt apical spine-setae. For mature Cayman material, the carpo-propodus of the endopods of thoracic limbs 3–5 is 3-articulate and limbs 6–8 are 2-articulate. This is in agreement with Brattegard's (1969) Bahamian specimens, but not his Antiguan specimens (3–6:3 articles, 7–8:2 articles) (Brattegard 1970b), nor Tattersall's (1951) material from the Gulf of Mexico and the Virgin Islands (3–7:3 articles, 8:2 articles).

***Parvimysis bahamensis* Brattegard, 1969**

*Parvimysis bahamensis*.—Brattegard 1969:74, Figures 23–24.—Henderson and Bamber 1983:143.

*Antromysis (Parvimysis) bahamensis*.—Bowman 1977:34.

*Mysidopsis cojimarensis* Ortiz and Lalana, 1993:51, Figures 1–2.—Price et al. 1994:684.

**Material.** GRAND CAYMAN ISLAND: (males-9, ovigerous females-7, immature females-5, juveniles-0), North Sound (19°23.20'N, 81°20.78'W), sand/seagrass, 2–3 m, epibenthic sled, night, 11 Jun 1997.—(53-43-24-0), North Sound, (19°23.40'N, 81°21.21'W), seagrass, 2–3 m, epibenthic sled, night, 11 Jun 1997.—(3-6-8-6), North Sound, off Duck Pond Cay, seagrass, 1.5 m, plankton net, epibenthic sled, night, 13 May 1998.—(9-28-3-2), North Sound, seagrass, 3 m, plankton net, epibenthic sled, night, 13 May 1998. LITTLE CAYMAN ISLAND: (15-19-4-4), South Hole Sound, middle, seagrass/sand, 1–2 m, epibenthic sled, night, 23 May 1995.—(0-2-0-0) South Hole Sound, middle, 1–2 m, plankton net, night, 23 May 1995.—(1-9-1-0), South Hole Sound, west end, sand, 1–2 m, epibenthic sled, night, 19 May 1995.—(4-7-1-2), Sound Hole Sound, west end, sand, 1.5 m, kicknet, 19 May 1995.—(1-0-1-1), Sandy Point, east end, sand, 1–2 m, kicknet, 23 May 1995.

**Type Locality.** Exumas, Bahamas.

**Distribution.** Coastal waters throughout the Caribbean Sea (Brattegard 1969, 1970b, 1973, 1974a, b, 1975; Modlin 1987a; Ortiz and Lalana 1993); Florida Keys (Brattegard 1973).

**Ecological remarks.** This species was collected commonly from patchy seagrass beds and sand at depths between 1 and 3 m in North Sound, Grand Cayman Island and South Hole Sound, Little Cayman Island. Brattegard (1969, 1973, 1974a, b, 1975) collected specimens in

sand as well as sand or mud substrata with seagrass beds in depths of 1–15 m. Small numbers of *Parvimysis bahamensis* were obtained by Modlin (1987) from fine sediments beneath prop roots of red mangroves, *Rhizophora mangle*.

Ovigerous females were 2.2–3.0 mm in length and carried 3–4 larvae per brood. Diameter of embryonic phase 0.22–25 mm; longest postnauplioid phase 1.04 mm.

**Systematic remarks.** Brattegard (1973) noted minor morphological differences among *P. bahamensis* specimens from the Caribbean coast of Colombia, Florida Keys, and Bahamas relating to the carapace, telson and chromatophore placement. The anterior dorsal margin of the carapace of our specimens is broadly rounded, most closely resembling the Colombian specimens of Brattegard. The ornamentation of the posterior telson margin is quite variable. This apparently led Ortiz and Lalana (1993) to consider Cuban specimens a new species of *Mysidopsis* Sars, 1864, *M. cojimarensis* (see Price et al. 1994). The emargination of the posterior end of the telson in our specimens is armed with 1–5 spinules and is closest to Brattegard's material from the Florida Keys. No chromatophores were found distal to the statocyst of the inner uropod for the Cayman specimens. Brattegard noted chromatophores only for Colombian material.

#### Tribe Heteromysini

##### *Heteromysis (Olivemysis) bermudensis* G.O. Sars, 1885

*Heteromysis bermudensis*.—G.O. Sars 1885:216, Plate 38, Figures 1–7.—Clarke 1955:5, Figure 7.—Brattegard 1973:51, Figure 20.

**Material.** GRAND CAYMAN ISLAND: (males-1, ovigerous females-0, immature females-0, juveniles-0), South Sound (Prospect Point), 1.5 m, rock washings, 19 May 1998.—(0-1-0-0), The Edge, 1.5–2.0 m, rock washings, 11 May 1998.—(5-1-4-1), Cottage Point, 1.0–2.0 m, rock washings, 23 May 1998.—(2-1-1-0), Spotter Bay, 1.0–1.5 m, rock washings, 16 May 1998.

**Type Locality.** Bermuda.

**Distribution.** Bermuda (G.O. Sars 1885, Verrill 1923, Clarke 1955, Bowman 1981, Băcescu and Iliffe 1986); Cuba (Băcescu 1968a); Grand Cayman (present study); Belize (Modlin 1987a); Caribbean coast of Colombia (Brattegard 1973); Saba Bank, Lesser Antilles (Brattegard 1980).

**Ecological remarks.** Most members of the genus *Heteromysis* are cryptic and commensal, living in association with various sessile or slow moving invertebrates (Vannini et al. 1994). The heteromysids taken in the

present study are probably no exception and were collected from habitats having a variety of calcareous algae, sponges, anthozoans, and other sessile forms. However, our collecting methods were too general to determine the specific host with which each mysid species was associated.

*Heteromysis bermudensis* was found in rock washings from several back reef sites on Grand Cayman Island. Other investigators obtained specimens from coral and shell rubble (Verrill 1923; Clarke 1955), empty queen conch shells *Strombus gigas* (Modlin 1987), sponges (Brattegard 1973; Băcescu and Iliffe 1986), and sponge and algae (Bowman 1981).

Ovigerous females ranged from 3.3–3.8 mm in length, but no larvae were present.

**Systematic remarks.** This species, which is represented by two nominal subspecies (*H.b. bermudensis* and *Heteromysis b. cesari* Băcescu, 1968), is presently known from Bermuda southward throughout the Caribbean. *Heteromysis b. bermudensis* has been reported from Bermuda while *H.b. cesari*, which was originally described from Cuba, has since been reported from Saba Bank by Brattegard (1980). The other three Caribbean records (Brattegard 1973; Băcescu and Iliffe 1986; Modlin 1987) do not indicate the subspecies. Based on eye morphology and the setal pattern of the male pleopod 4, our material from the Grand Cayman fits *H.b. bermudensis sensu* Bowman (1981); however, until more details are available on the intraspecific variation within this species, we follow Modlin (1987) and do not recognize its subspecific status.

In most respects, our material agrees with earlier descriptions of *H. bermudensis* (see Bowman 1981) but exhibits more variation than previously reported. The inner margin of the uropodal endopod is armed with 10–14 spine-setae; the spinules of the telsonal cleft ranges from 11–17; the distal margin of male pleopod 4 and the carpo-propodus of thoracic endopod 3 have 42–55 and 6–7 flagellated spine-setae, respectively. A faint distal suture was noted on the antennal scale of all Cayman specimens examined and is in agreement with Sars (1885) and Bowman (1981), but not Băcescu (1968) or Brattegard (1973).

##### *Heteromysis (Olivemysis) coralina* Modlin, 1987

*Heteromysis coralina*.—Modlin 1987b:657, Figure 2a–k.

**Material.** GRAND CAYMAN ISLAND: (males-1, ovigerous females-1, immature females-1, juveniles-0), Spotter Bay, 1.0–1.5 m, rock washings, 16 May 1998.

LITTLE CAYMAN ISLAND: (1-0-1-3), Sandy Point, 1.0–1.5 m, rock/algal washings, 23 May 1995.

**Type Locality.** Looe Key, Florida Keys, Florida.

**Distribution.** Florida Keys (Modlin 1987b); Cayman Islands (present study).

**Ecological remarks.** This species was collected from rock and rock/algal washings on Grand Cayman Island and Little Cayman Island. Modlin (1987b) obtained specimens from a fore reef vertical buttress wall with hard and soft coral after the area was poisoned.

The only ovigerous female collected was 4.0 mm long.

**Systematic remarks.** Specimens from this second record of *Heteromysis coralina* exhibit greater variation for a number of morphological characteristics than reported in Modlin's (1987) original description. The endopod of the uropod is armed with 2–4 spine-setae near the statocyst rather than 5; the proximal half of the telsonal cleft has 13–17 spinules rather than 19–20; 7–10 spine-setae (including apical spine-setae) are located along the lateral margins of the telson rather than 10; and the distal margins of pleopods 3 and 4 of males (3.9, 4.3 mm length) have 6–12 and 8–17 flagellated spine-setae, respectively. Modlin reported 8–11 and 14–15 flagellated spine-setae for male pleopods 3 and 4, respectively. The carpo-propodus of thoracic endopod 3 of our specimens is armed with 8–9 flagellated spine-setae with the distal 2–3 pairs tuberculate. Modlin (1987) reported 9 flagellated spine-setae, and his illustration (Figure 2G) showed tubercles on at least the distal two pairs.

#### *Heteromysis (Olivemysis) mayana* Brattegard, 1970

*Heteromysis mayana*.—Brattegard 1970a:140, Figure 12–13.

**Material.** GRAND CAYMAN ISLAND: (males-0, ovigerous females-3, immature females-1, juveniles-0), South Sound, west end, sand/seagrass, 1–2 m, rock/sponge/algal washings, 22 May 1998.—(0-2-0-0), South Sound (Pier), sand/seagrass, 1.0–1.5 m, rock washings, 30 Aug 1996.—(6-1-4-1), same station, rock washings, 15 Jun 1997.—(5-3-2-0), Spotter Bay, 1.0–1.5 m, rock washings, 16 May 1998.—(12-6-1-4), North Beach, grass/sand, 1.0–1.5 m, rock washings, 1 Sep 1996.—(12-5-5-2), same station, yabby pump, 12 May 1998.—(0-1-0-0), North Sound, off Booby Cay, seagrass, 3 m, epibenthic sled, night, 13 May 1998.

**Type Locality.** Isla de Cozumel, Quintana Roo, Mexico.

**Distribution.** Quintana Roo, Mexico (Brattegard 1970b; Markham et al. 1990); Belize (Modlin 1987a);

Caribbean coast of Colombia (Brattegard 1973, 1974a); tentatively from the Virgin Islands (Brattegard 1975); Grand Cayman (present study).

**Ecological remarks.** Most specimens were collected in rock washings and from sand bottoms with patchy seagrass. Brattegard (1970b, 1973, 1974a) reported this species from a variety of habitats: green sea anemones, *Thalassia* beds, coral rubble, and live hard corals. Modlin (1987a) found it in coral rubble, empty queen conch shells, and in association with the sea anemone *Bartholomea annulata*.

Ovigerous females ranged from 2.7–4.2 mm long. Only one with an undisturbed marsupium was collected; it harbored 4 postnauplioid larva that were each 0.9 mm in length.

**Systematic remarks.** Our material from Grand Cayman constitutes the first record of this species from an insular environment and shows greater morphological variation than reported by Brattegard (1970b). The posterior 60–70%, rather than 50%, of the lateral telson margin is armed with spine-setae; the inner apical telson spine-setae are greater than half the length of the outer rather than less than half; the telsonal cleft is about 1/3 the telson length rather than 1/4. Brattegard reported 5 non-tuberculate flagellated spine-setae on the carpo-propodus of thoracic endopod 3. Our specimens have 5–7 flagellated spine-setae with tubercles on all but the most proximal one. Brattegard found 18–22 and 30–35 flagellated spine-setae for male pleopods 3 and 4, respectively, as opposed to 13–20 and 19–32 spine-setae for the Cayman material.

#### *Heteromysis (Olivemysis) sp. A*

**Material.** GRAND CAYMAN ISLAND: (males-2, ovigerous females-1, immature females-0, juveniles-0), South Sound, west end, sand/seagrass, 1–2 m, rock/sponge/algal washings, 22 May 1998.—(3-2-2-1), South Sound, (Prospect Point), 1.5 m, rock washings, 18, 19 May 1998.—(2-0-0-0), same station, rock washings, 12 Aug 1999.—(0-1-0-0), The Edge, 1–2 m, rock washings, 11 May 1998.—(3-2-0-0), Cottage Point, 1–2 m, rock washings, 23 May 1998.—(1-1-0-0), same station, rock washings, 13 Aug 1999.

**Ecological remarks.** Specimens were collected from rock and rock/sponge/algal washings from 4 stations along the south coast of Grand Cayman Island.

**Systematic remarks.** This undescribed species of *Heteromysis* is most closely related to *H. agelas*, *H. bredini*, *H. gutarti*, and *H. tuberculospina* but differs from these species in the setation of the antennular

peduncle, thoracic endopod 3, uropodal endopod, telson, and male pleopod 4. Our specimens have a non-tuberculate spine-seta on the third article of the antennule, 6 flagellated spine-setae on the carpo-propodus of thoracic endopod 3, 3–4 uropodal endopod spine-setae, telsonal cleft with 11–16 spine-setae, and inner apical telson spine-setae more than one-half as long as outer spine-setae. In addition, pleopod 4 of mature males has 5 modified spine-setae.

### *Heteromysis* (*Olivemysis*) sp. B

**Material.** GRAND CAYMAN ISLAND: (males-0, ovigerous female-1, immature females -0, juveniles-0), North Sound (19°20.00'N, 81°21.66'W), seagrass, 2–3 m, epibenthic sled, night, 11 Jun 1997. LITTLE CAYMAN ISLAND: (0-0-1-0), South Hole Sound, middle, 1–2 m, sponge washings, 22 May 1995.—(7-5-4-0), South Hole Sound, west end, sand/seagrass, 1–2 m, epibenthic sled, night, 19 May 1995.—(12-6-4-1), Owen Island, west end, 1.0–1.5m, rock/algal washings, 23, 25 May 1995.—(11-5-2-0), Sandy Point, 1.0–1.5m, rock/algal washings, 23 May 1995.

**Ecological remarks.** Most specimens were taken from sponge washings, rock/algal washings, and sand/seagrass habitats on Little Cayman Island. However, one individual was collected from seagrass in North Sound, Grand Cayman Island, indicating that this species is probably established in the shallow waters surrounding both islands.

**Systematic remarks.** This species appears to be undescribed and most closely related to *H. bermudensis* and *H. floridensis*. The major difference separating these species concerns the setation of the distal margin of pleopod 4 in mature males. Mature male *H. bermudensis* and *H. floridensis* have 26 or more flagellated or non-flagellated spine-setae on pleopod 4, whereas our specimens have 10 or fewer flagellated spine-setae.

### DISCUSSION

Of the 20 species of mysids recorded from the Cayman Islands, the two undescribed species of *Heteromysis* are known currently only from this insular cluster. In addition to establishing new distribution records for *Heteromysis coralina* (Florida Keys), *Mysidopsis mathewsoni* (Bahamas), *Siriella chessi*, and *S. macrophthalama* (Virgin Islands), these species are reported for the first time since their original descriptions. The other 14 species have widespread distributions throughout the Caribbean Sea, including the

continental coastlines of Central America and northern South America, and their appearance in the shallow water communities of the Cayman Islands is not considered unusual.

Species diversity of Cayman mysid fauna is similar to results from other intensive surveys of mysids in insular or continental coastline locales within the Caribbean. Brattegard (1969, 1970a) found 13 species in the Florida Keys and Biscayne Bay area, 16 species in the Bahamas, and 22 and 34 species along the coastlines of Panama and Colombia, respectively (Brattegard 1973, 1974a, b). Modlin (1987a) collected 11 species from the water surrounding Carrie Bow Cay, Belize. Collecting methods and total sampling effort varied considerably among these studies. For example, Brattegard utilized an epibenthic sled for most samples, and collected in shallow waters of 15 m or less in the Florida Keys, Bahama, and Panama. In contrast, Modlin sampled specific benthic (sponge, corals) and planktonic habitats within coral and mangrove communities, utilizing SCUBA and snorkeling techniques. The Colombian survey (Brattegard 1973, 1974a), which yielded the greatest number of species, had more stations from a greater depth range (1–45 m) and used a wider variety of sampling methods than any other Caribbean survey. Sampling in the present study was restricted to shallow non-reef habitats surrounding Grand Cayman and Little Cayman Islands and the slightly deeper waters of North Sound. The extensive fore reef habitats ringing the islands were not sampled, nor were specific benthic habitats targeted as they were in Modlin's (1987a) Belize study. Inclusion of these reef and non-reef areas in future faunal surveys of mysids of Grand Cayman, Little Cayman, and Cayman Brac should provide a more complete picture of the diversity, endemism, and zoogeography for the Mysida occurring in the waters of this small, remote group of Antillean islands.

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## TANAIDACEA (CRUSTACEA: PERACARIDA) OF THE GULF OF MEXICO. X. THE QUESTION OF BEING MALE

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**ABSTRACT** Three new species *Parafilitanais mexicana*, *Collettea elongata*, and *Paragathotanaais medius* are described from deep-sea localities in the Gulf of Mexico. The male of *Parafilitanais* does not vary conspicuously from the female, except for possessing pleopods. Male *Paragathotanaais* reveal that the mouthparts display some degree of sexual dimorphism. Males of all 3 species possess functional mouthparts. The problems identifying male Tanaidacea are discussed. The number of terminal spiniform setae on the maxillule is considered invalid as a diagnostic character. Keys to the species of *Parafilitanais* and *Paragathotanaais* are given.

### INTRODUCTION

During a study on the comparative biodiversity of the Tanaidacea in the Gulf of Mexico (Larsen, in progress), a large number of new deep-sea species were discovered, including one new species belonging to each of the genera *Parafilitanais* Kudinova-Pasternak, 1989, *Collettea* (G.O. Sars, 1882), and *Paragathotanaais* Lang, 1971.

The study of Tanaidacea becomes seriously impaired when dealing with males (for review see Larsen 2001), and large holes in our understanding of the reproductive strategies in Tanaidacea exist. It is clear that in some shallow-water taxa (e.g., Leptocheliidae) several morphologically different males with rudimentary mouthparts exist in a given species, while in other taxa (Tanaididae, Apseudomorpha) there is only one male which generally resembles the female and retains functional mouthparts. When focus is directed on the deep-sea taxa, the picture becomes unclear. Neotanaidomorphans have two male morphs and the male mouthparts are rudimentary (Gardiner 1975). The tanaidomorphans have been considered either parthenogenetic or as having morphologically different males with rudimentary mouthparts (Sieg 1984). However, observing the penes of male tanaidomorphans is exceedingly difficult and thus males have to be sexed using other characters.

Male leptognathids differ substantially from females (Wilson 1987) and the two sexes share no species characters. Whether more than one type of male is involved is not known at this stage but has never been documented for any species. It seems unlikely that more than one type of male exists for each species, given the low ratios of males to females found in deep-sea samples. Agathotanaids, in contrast to the leptognathids, appear to have only one type of male, which differs from the female only in the presence of pleopods and a thicker

antennule (Bird and Holdich 1988, Larsen 1999). Larsen (1999) reported mouthpart reduction in the adult male of *Agathotanaais spinipoda* Larsen, 1999 but re-examination revealed that this was a mistake based on a bad dissection. The same pattern of limited sexual dimorphism is found in the deep-sea genus *Collettea* (Larsen 2000), and no non-feeding terminal male stage has been identified in any of these genera. It is not known if these males are, in fact, “subadult” or if a terminal and morphologically different stage has escaped observation. This is highly unlikely given that an enormous amount of material is available for these taxa, particularly that of *Agathotanaais* Hansen, 1913. Lang (1968) mentioned that several “subadult males” are identical to the female, except for the presence of pleopods and a thicker antennule. Sieg (1986) questioned the validity of these ‘subadult’ males and suggested that they might be separate female morphs or species. Sieg (1986) also disputed the male characters presented by Lang (1968) and suggested that mature males would lack mouthparts. During the present study, the kind of male characters identified by Lang (1968) were observed in males of all three species, and despite the large amount of material available to me, no non-feeding terminal male stage was observed from the genera mentioned here or from *Tanaella* Norman and Stebbing, 1886 or *Agathotanaais*. The same “male characteristics” have been identified in *Tanaella* (G. Bird, personal communication, West Dayton, Middlesex, UK). It is here suggested that in the genera *Parafilitanais*, *Paragathotanaais*, *Tanaella*, *Agathotanaais*, and *Collettea*, males retain functional mouthparts and that the “subadults” described by Lang, Kudinova-Pasternak, and others are, in fact, fully mature males. This condition is possibly true for several additional genera/species and it must be expected that several leptognathids described as females with pleopods are actually just males.

*Parafilitanais* was erected by Kudinova-Pasternak (1989) to accommodate *P. caudatus* Kudinova-Pasternak, 1989. *Parafilitanais mexicana*, described herein, is only the third species and the first male to be described for this deep-sea genus.

The Genus *Paragathotanaïs* was erected by Lang (1971) and later revised by Bird and Holdich (1988) but still contains only five species. *Paragathotanaïs* was initially described as having a 5-articulated antenna (Lang 1971), but Bird and Holdich (1988) re-diagnosed the genus as having a 6-articulated antenna. *Paragathotanaïs* is thus separated from *Agathotanaïs* by having a 6- (or 5-) articulated antenna, a 4-articulated antennule and uropodal endopod not fused to the protopod (Lang 1971). *Agathotanaïs* has a reduced antenna, a 3-articulated antennule, and a uropodal endopod fused to the protopod. However, Larsen (1999) found significant variation in the reduction of the antenna in *Agathotanaïs*; the new species *Paragathotanaïs medius*, described herein, also displays reduction in the antenna. Since *P. medius* has a 4-articulated antennule and the uropodal endopod is not fused to the protopod, it belongs to *Paragathotanaïs* with the modified generic diagnosis provided herein.

The Genus *Collettea*, recently revised by Larsen (2000) and currently containing 14 species, has proved to be a cosmopolitan genus present in most deep-sea collections.

Holotype material is deposited in the National Museum of Natural History, Washington, DC, USA. Paratypes and other material are deposited in the collection of the Gulf Coast Research Laboratory (GCRL). Material was collected by Texas A&M University staff.

## SYSTEMATICS

### *Parafilitanais* Kudinova-Pasternak, 1989

**Diagnosis.** (Modified after Kudinova-Pasternak 1989). Female: Body elongated and cylindrical. Antennule with 4 articles. Antenna with 5–6 articles. Mandible molar pointed. Labium consists of 1 pair of lobes without lateral or medial processes. Maxilliped basis fused distally, endites not fused, narrower than basis and with 1 minute distal denticle. Chelipeds attached ventrally. Pereopods 1–3 with coxa, dactylus, and terminal setae shorter than propodus. Pereopod 4–6 without coxa; dactylus and terminal seta as long or longer than propodus, not fused to a claw. Pleopods absent. Uropods long and uniramous, endopod consists of 2 articles.

Male: Body shorter than female. Functional mouthparts present in adult males, resembling but not identical to female. Antennule only marginally thicker than female. Pleonites with reduced pleopods with simple setae (juvenile male pleopods without setae).

**Remarks.** *Parafilitanais* may represent a case of reverse evolution from the *Tanaella* type (completely reduced uropodal exopod) towards the *Leptognathia* type (reduced mandibular molar). It is unlikely that a uropodal exopod will reappear once lost, while it is reasonable to expect the mandibular molar to alter shape depending on diet. The decrease in body size, elongated cheliped, and pointed mandible molar could all be adaptations for deep-sea dwelling.

### *Parafilitanais mexicana* sp. nov. (Figures 1–4)

**Material examined.** 1 non-ovigerous female. Holotype, body length 1.6 mm. Station C4-1. 31 May 00. 27°27.5640'N, 89°47.1391'W. Depth 1455 m. Paratypes: 1 non-ovigerous female. Same locality. 1 male. Station C7-2. 30 May 00. 27°43.971'N, 89°58.6211'W. Depth 1070 m.

**Other material.**—1 non-ovigerous female, 1 manca. Station C4-1. 31 May 00. 27°27.5640'N, 89°47.1391'W. Depth 1455 m.—1 non-ovigerous female Station. C7-1. 30 May 00. 27°43.6967'N, 89°58.7782'W. Depth 1080 m.—1 male, 3 non-ovigerous females. Station MT2-1. 17 Jun 00. 28°27.0646'N, 89°40.3563'W. Depth 676 m.—1 non-ovigerous female. Station MT4-1. 15 Jun 00. 27°49.6198'N, 89°09.9526'W. Depth 1401 m.—1 non-ovigerous female. Station NB4-1. 11 May 00. 26°15.2711'N, 92°23.6978'W. Depth 2030 m.—1 male, 1 non-ovigerous female, 2 mancass. Station S35-1. 11 Jun 00. 29°20.0500'N, 87°03.3758'W. Depth 658 m.—4 non-ovigerous females. Station W2-1. 14 May 00. 27°24.8008'N, 93°20.2579'W. Depth 625 m.—3 non-ovigerous females. Station W3-1. 14 May 00. 27°10.3711'N, 93°19.3081'W. Depth 860 m.—1 non-ovigerous female. Station W12-1. 05 May 00. 27°19.3945'N, 91°33.3486'W. Depth 1168 m.—13 non-ovigerous females. Station C7-2. 30 May 00. 27°43.9713'N, 89°58.6211'W. Depth 1070 m.—7 non-ovigerous females. Station S35-2. 11 Jun 00. 29°19.9897'N, 87°02.9021'W. Depth 667 m.—2 non-ovigerous females. Station S42-2. 10 Jun 00. 28°15.1070'N, 86°25.0209'W. Depth 768 m.

**Diagnosis.** Female: Body not tapering distally. Carapace shorter than combined length of 2 pereonites. Maxillule with 2 bifurcate terminal setae. Cheliped dac-

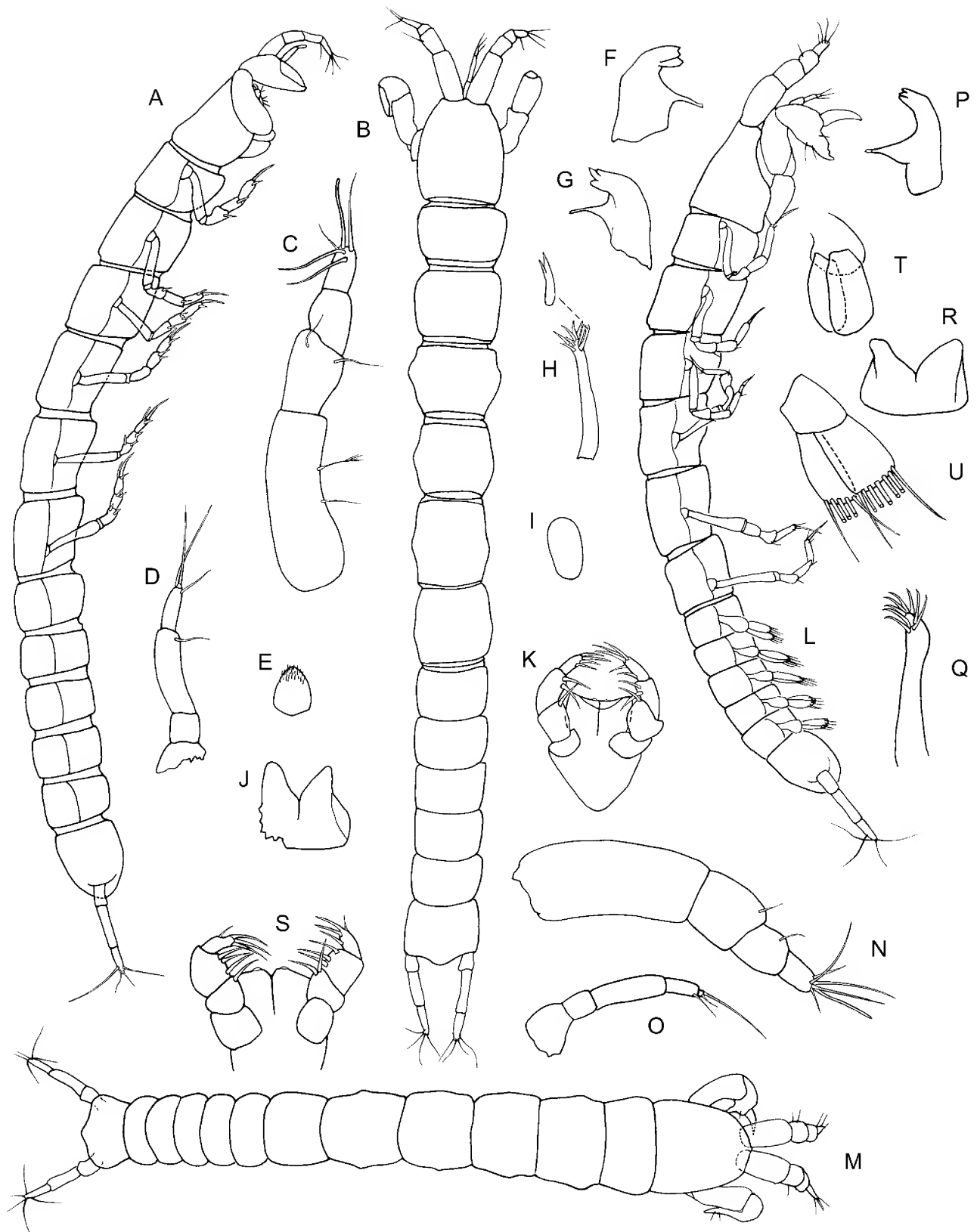


Figure 1. *Parafilitanais mexicana*. A. Female holotype, lateral view. B. Same, dorsal view. C. Female antennule. D. Female antenna. E. Female labrum. F. Female left mandible. G. Female right mandible. H. Female maxillule. I. Female maxilla. J. Female labium. K. Female maxilliped. L. Male paratype, lateral view. M. Same, dorsal view. N. Male antennule. O. Male antenna. P. Male right mandible. Q. Male maxillule. R. Male labium. S. Male maxilliped. T. Juvenile male pleopod. U. Mature male pleopod.

tylus marginally longer than fixed finger. Pleotelson apex not acute.

Male. As female except cheliped dactylus not longer than fixed finger and maxillule without bifurcate setae.

**Etymology.** Named after the locality, the Gulf of Mexico

**Description.** Adult female.

Body. (Figures 1A, B) Elongated, 10 times longer than broad.

Cephalothorax. Shorter than combined length of pereonite 1 and 2. Eye lobes absent.

Pereonites. Pereonites 1, 2, 3, 4, and 6 wider than long. Pereonite 5 as wide as long.

Pleon. All pleonites subequal, slightly narrower than pereon and half as long. Pleotelson (Figure 2H) only marginally longer than individual pleonites, apex blunt, almost flat.

Antennule. (Figure 1C) As long as cephalothorax. Article 1 as long as rest of antennule, with 1 simple seta and 1 sensory medial seta. Article 2 shorter than 1/2 of article 1, with 2 simple distal setae. Article 3 length 2/3 article 2, smooth. Article 4 marginally shorter than article 3, with 3 thick, long setae, 1 simple distal seta and 1 aesthetasc.

Antenna. (Figure 1D) Half as long as antennule. Article 1 broken but broader than following articles. Article 2 length 1/3 article 3, smooth. Article 3 longer than other articles, with 1 simple distal seta. Article 4 half as long as article 3, with 1 simple distal seta. Article 5 minute with 2 long distal setae.

Mouthparts. Labrum (Figure 1E) setose and hood-shaped. Mandibular molar process pointed and longer than incisor, with small distal denticles. Left mandible (Figure 1F) lacinia mobilis almost as broad as incisor; incisor with 2 pointed denticles. Right mandible (Figure 1G) incisor broad, with 3 large, blunt denticles (medial denticle anteriorly directed). Maxillule (Figure 1H) endite with 8 distal spiniform setae, of which 2 are bifurcate. Palp not recovered. Maxilla (Figure 1I) ovoid. Labium (Figure 1J) apex rather pointed and smooth. Maxilliped (Figure 1K) endites with 1 small denticle. Basis fused. Palp article 1 broader than other articles and smooth. Article 2 with 1 thick seta on inner margin. Article 3 with 2 thick setae. Article 4 with 4 distal thick setae. Epignath not recovered.

Cheliped. (Figure 2A) Basis divided unequally by sclerite, as long as carpus. Merus triangular with 2 ventral setae. Carpus shorter than propodus including

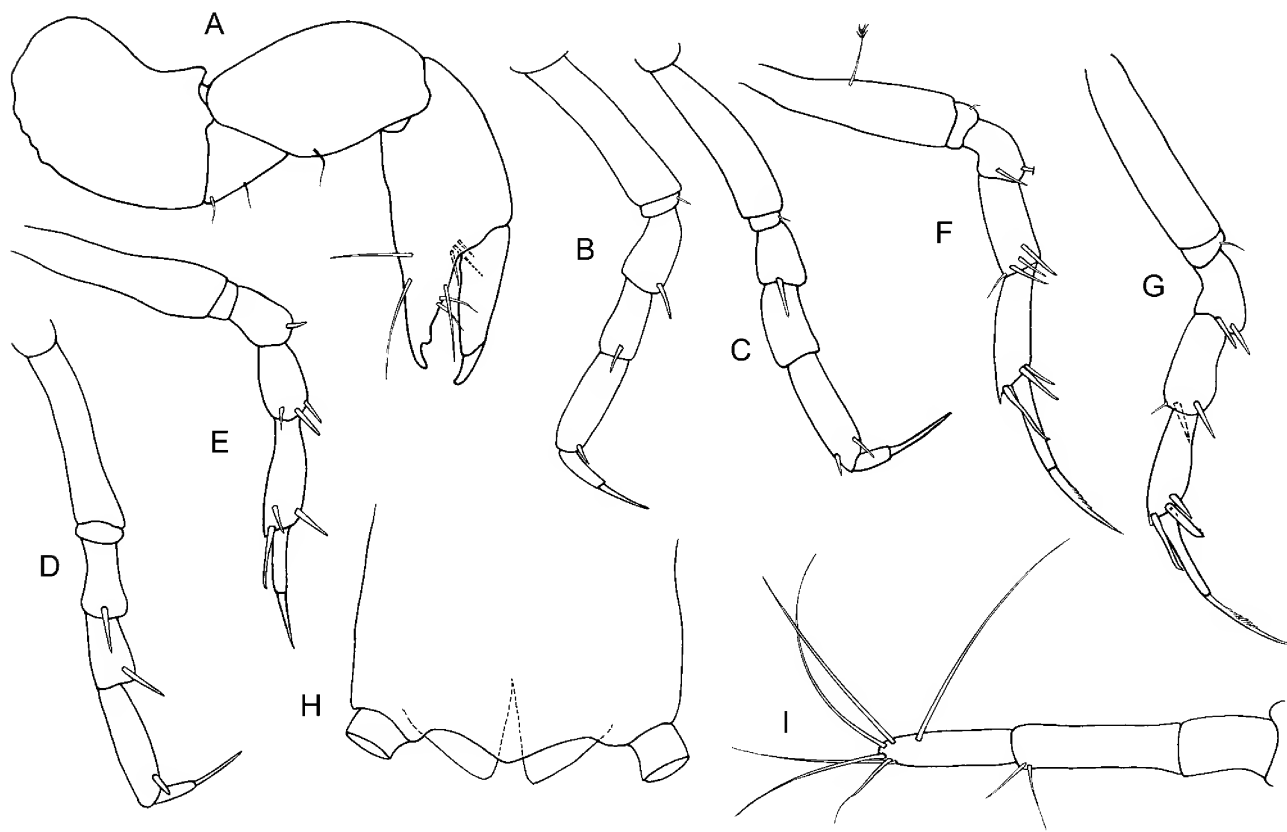


Figure 2. *Parafilitanais mexicana*, female. A. Cheliped. B. Pereopod 1. C. Pereopod 2. D. Pereopod 3. E. Pereopod 4. F. Pereopod 5. G. Pereopod 6. H. Pleotelson. I. Uropod.

the fixed finger, with 1 ventral seta. Propodus slender, with 3 setae near dactylus insertion. Fixed finger with 2 ventral setae, 3 on inner margin. Dactylus marginally longer than fixed finger.

Pereopod 1. (Figure 2B) Coxa deep and circular, smooth. Basis as long as 3 succeeding articles combined, smooth. Ischium with 1 small ventral seta. Merus longer than carpus, widening distally and with 1 spiniform distal seta. Carpus 2/3 length of propodus, with 1 spiniform distal seta. Propodus longer than 1/2 the length of basis, with 1 spiniform distal seta. Dactylus and terminal seta only marginally shorter than propodus.

Pereopod 2. (Figure 2C) As pereopod 1 except carpus smooth and longer than merus. Propodus with 2 spiniform setae. Dactylus and terminal setae clearly shorter than propodus.

Pereopod 3. (Figure 2D) As pereopod 1 except ischium smooth. Dactylus and terminal setae clearly shorter than propodus.

Pereopod 4. (Figure 2E) Basis smooth, longer than 3 succeeding articles combined. Ischium smooth. Merus shorter than carpus, with 1 spiniform distal setae. Carpus with 3 spiniform distal setae. Propodus with 2 spiniform and 1 elongate, hook-shaped distal seta. Dactylus and terminal seta longer than propodus, not fused to a claw.

Pereopod 5. (Figure 2F) as pereopod 4 except basis with 1 sensory medial seta. Ischium with 1 simple seta. Merus with 2 spiniform distal setae. Propodus with 2 spiniform and 1 elongate, hook-shaped distal seta and dorsal spine. Terminal seta with medial serration.

Pereopod 6. (Figure 2G) Similar to pereopod 5 except basis without sensory seta. Carpus with 3 spiniform distal setae.

Uropods. (Figure 2I) Protopod more than 1/2 the length of endopod article 1, smooth. Endopod article 1 longer than article 2, with 2 simple distal setae; article 2 with 6 long, simple distal setae. Exopod reduced to a small process on protopod.

**Description.** Adult male (when different from female).

Body. (Figures 1L, M) Elongated, 7.5 times longer than broad.

Pleon. All pleonites subequal and bearing pleopods, as wide as pereon. Pleotelson laterally widening distally, only marginally longer than individual pleonites.

Antennule. (Figure 1N) Only marginally wider than female.

Mouthparts. Right mandible (Figure 1P) as in female but medial denticle smaller and not anteriorly directed. Maxilliped (Figure 1S) endite denticles larger

than female. Palp article 4 with 3 thick distal setae on inner margin and 1 smaller seta on outer margin.

Cheliped. (Figure 3A) Dactylus not longer than fixed finger.

Pleopod. (Figures 1T, U) Protopod widening distally, smooth. Endo- and exopod with 5 and 7 simple setae, respectively. Juvenile male pleopods without setae.

**Remarks.** *Parafilitanais mexicana* can easily be separated from the other species in the genus, *P. caudatus* Kudinova-Pasternak, 1989 and *P. similis* Kudinova-Pasternak, 1990, by the flat apex of the pleotelson and by the fact that the body is not tapering distally. The cheliped dactylus of the female *P. mexicana* is also longer than that of *P. caudatus*. The antenna of *P. caudatus* appears to be 6-articulated, while 5-articulated in *P. mexicana*, but this character is not given much weight here since it is considered to be unreliable (Larsen, research in progress). Unfortunately not much can be said about *P. similis*, which is inadequately described and illustrated.

#### KEY TO PARAFILITANAIS

1. Pleotelson apex flat. Cheliped dactylus of female longer than fixed finger. Body not tapering distally ..... *P. mexicana*

Pleotelson apex pointed. Cheliped dactylus of female not longer than fixed finger. Body tapering distally ... 2

2. Pereonite 1 about 2/3 length of pereonite 2. Pleon about 1/4 of total body length ..... *P. similis*

Pereonite 1 about 9/10 length of pereonite 2. Pleon about 1/3 of total body length ..... *P. caudatus*

#### Genus *Collettea* (G.O. Sars, 1882)

##### *C. elongata* sp. nov. (Figures 5-7)

**Material examined.** 1 non-ovigerous female holotype, body length 1.7 mm. Station. WC8 5445-3. 27°50.23'N, 90°44.01'W. Depth 550 m. 1 non-ovigerous female paratype. Station WC5-5425-1. 27°47.13'N, 91°46.12'W. Depth 291 m. 1 male. Station C12-2. 14 May 00. 27°24.7019'N, 93°20.3849'W. Depth 625 m. 1 non-ovigerous female. Station NB2-1. 07 May 00. 27°08.0243'N, 91°59.9584'W. Depth 1530 m.

**Other material.**—2 non-ovigerous females. Station WC6-5436-6. 27°42.37'N, 91°33.04'W. Depth 554 m.—2 non-ovigerous females. Station WC6-5432-2. 27°42.43'N, 91°33.02'W. Depth 580 m.—1 non-ovigerous female. Station WC7-5437-1. 27°45.37'N,

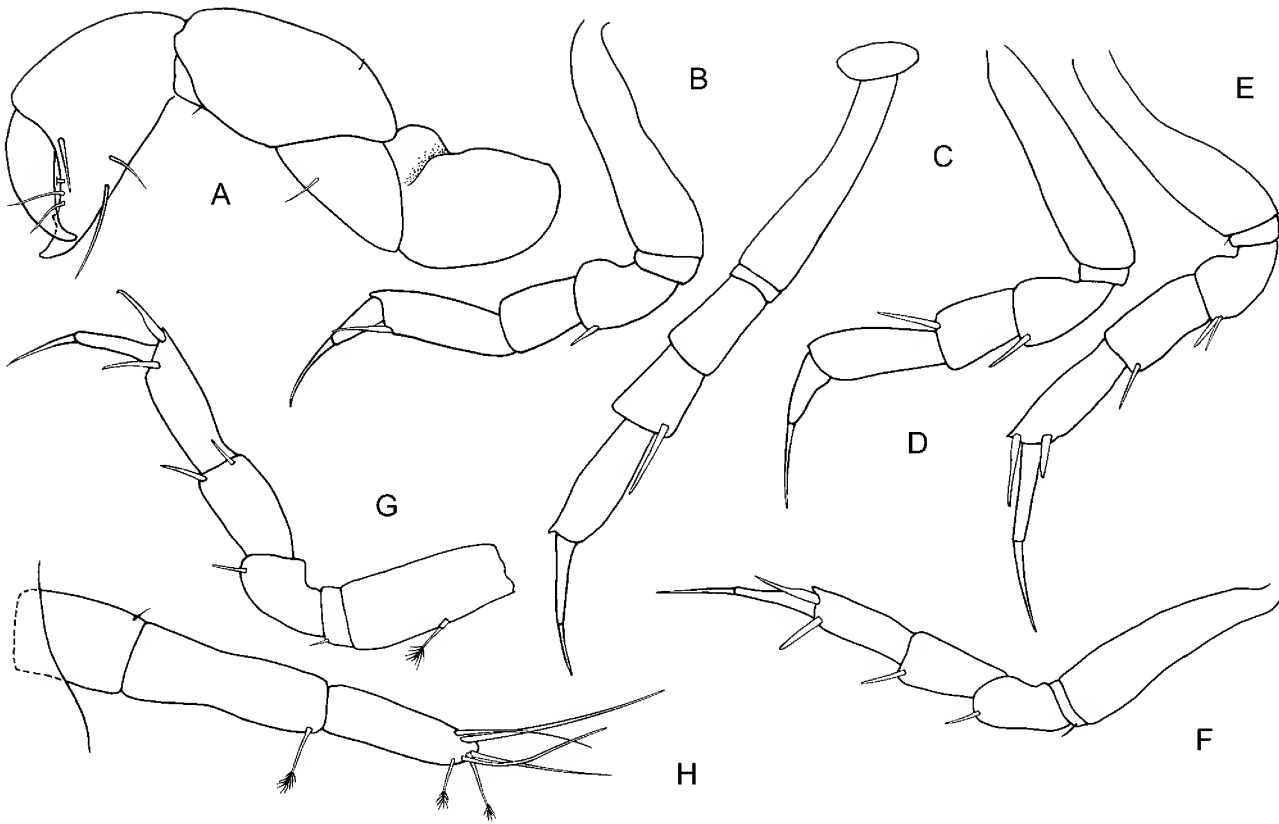


Figure 3. *Parafilitanais mexicana*, male. A. Cheliped. B. Pereopod 1. C. Pereopod 2. D. Pereopod 3. E. Pereopod 4. F. Pereopod 5. G. Pereopod 6. H. Uropod.

91°13.07'W. Depth 455 m.—1 non-ovigerous female. Station 3C-4436-6. 27°49.6'N, 90°06.8'W. Depth 853 m.—1 non-ovigerous females. Station E2-4454-4. 28°16.45'N, 86°14.45'W. Depth 622 m.—1 non-ovigerous female. Station. WC8-5467-1. 27°50.30'N, 90°44.07'W. Depth 545 m.—1 non-ovigerous female. Station S36-2. 12 Jun 00. 28°55.0080'N, 87°40.0627'W. Depth 1832 m.—1 non-ovigerous female. Station S43-1. 10 Jun 00. 28°30.1055'N, 86°04.9983'W. Depth 366 m.—1 non-ovigerous female. Station W4-1. 15 May 00. 26°43.9027'N, 93°19.1708'W. Depth 1420 m.—1 non-ovigerous female. Station W12-1. 05 May 00. 27°19.3945'N, 91°33.3486'W. Depth 1168 m.—1 non-ovigerous female. Station C7-1. 30 May 00. 27°43.6967'N, 89°58.7782'W. Depth 1080 m.—1 non-ovigerous female, Station W1-1. 13 May 00. 27°34.7791'N, 93°32.8573'W. Depth 379 m.—1 non-ovigerous female, 1 male, Station W3-1. 14 May 00. 27°10.3711'N, 93°19.3081'W. Depth 860 m.—3 non-ovigerous females Station C4-1. 31 May 00. 27°27.5640'N, 89°47.1391'W. Depth 1455 m.—1 non-ovigerous female, Station RW6-2. 18 May 00. 26°00.142'N, 94°29.381'W. Depth 3015 m.—4 non-ovigerous females, 3 males. Station S36-1. 12 Jun 00.

28°55.1647'N, 87°40.2232'W. Depth 1825 m.—4 non-ovigerous females. Station W2-2. 14 May 00. 27°24.7019'N, 93°20.3849'W. Depth 625 m.

**Diagnosis.** Body 12 times longer than broad. Antenna article 4 without fusion line. Maxilliped endite without process. Cheliped fixed finger without processes. Cheliped dactylus not longer than fixed finger. Heavy armament with spiniform setae only on pereopod 4–6. Uropods long (>0.3 times pleotelson length).

**Etymology.** Named to reflect the elongated body-shape, which is unique in the genus (Latin: elongata=female form of elongated)

**Description.** Adult female.

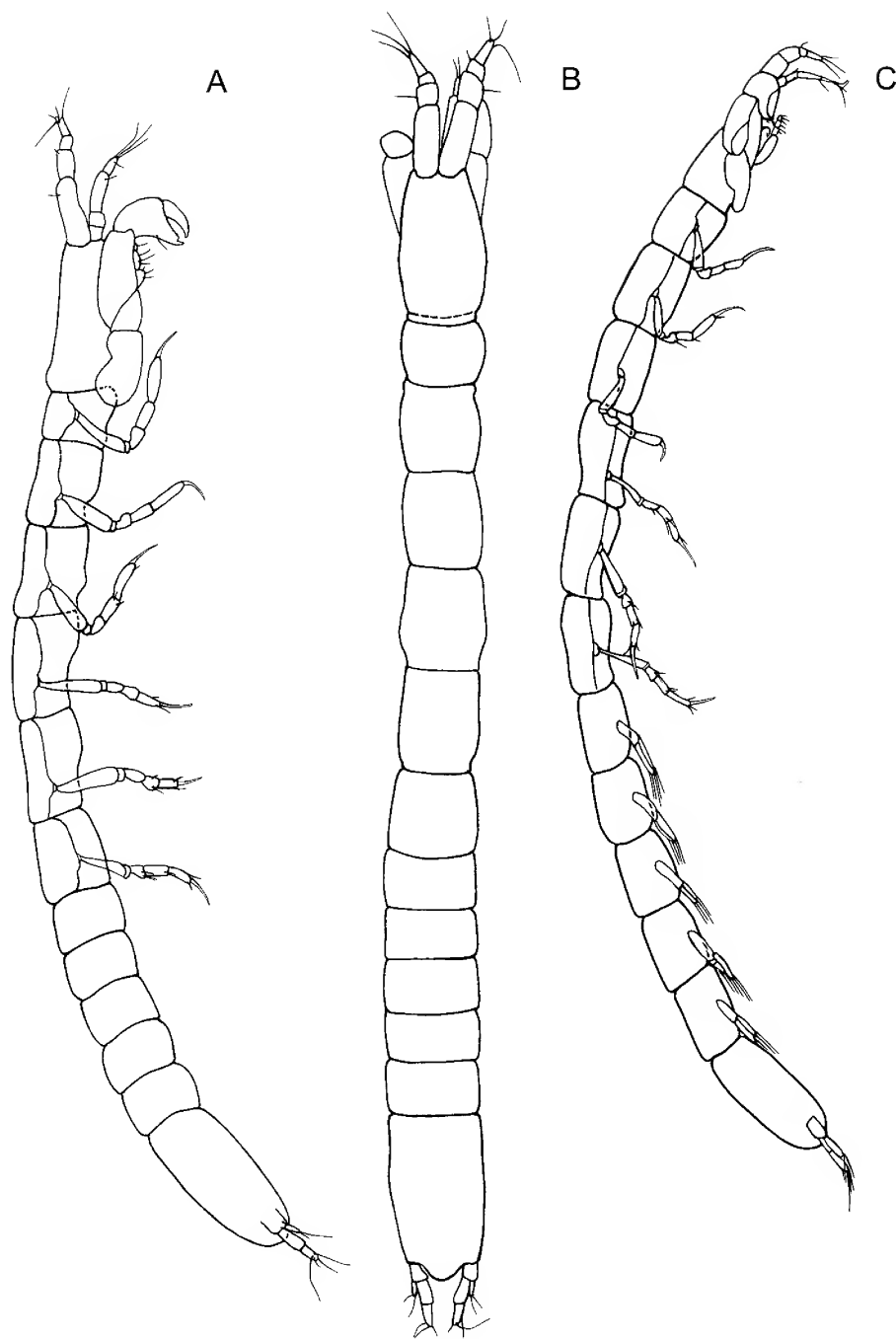
Body. (Figures 4A, B) 12 times longer than broad.

Cephalothorax. As long as combined length of pereonite 1 and 2.

Pereonites. Pereonites 1 and 6 wider than long. Pereonite 2 as long as wide. Pereonites 3, 4, and 5 longer than wide.

Pleon. All pleonites subequal. Pleotelson longer than combined length of 3 pleonites and tapering into a cone shaped apex.

Antennule. (Figure 5A) With 5 articles. As long as cephalothorax. Article 1 longer than rest of antennule,



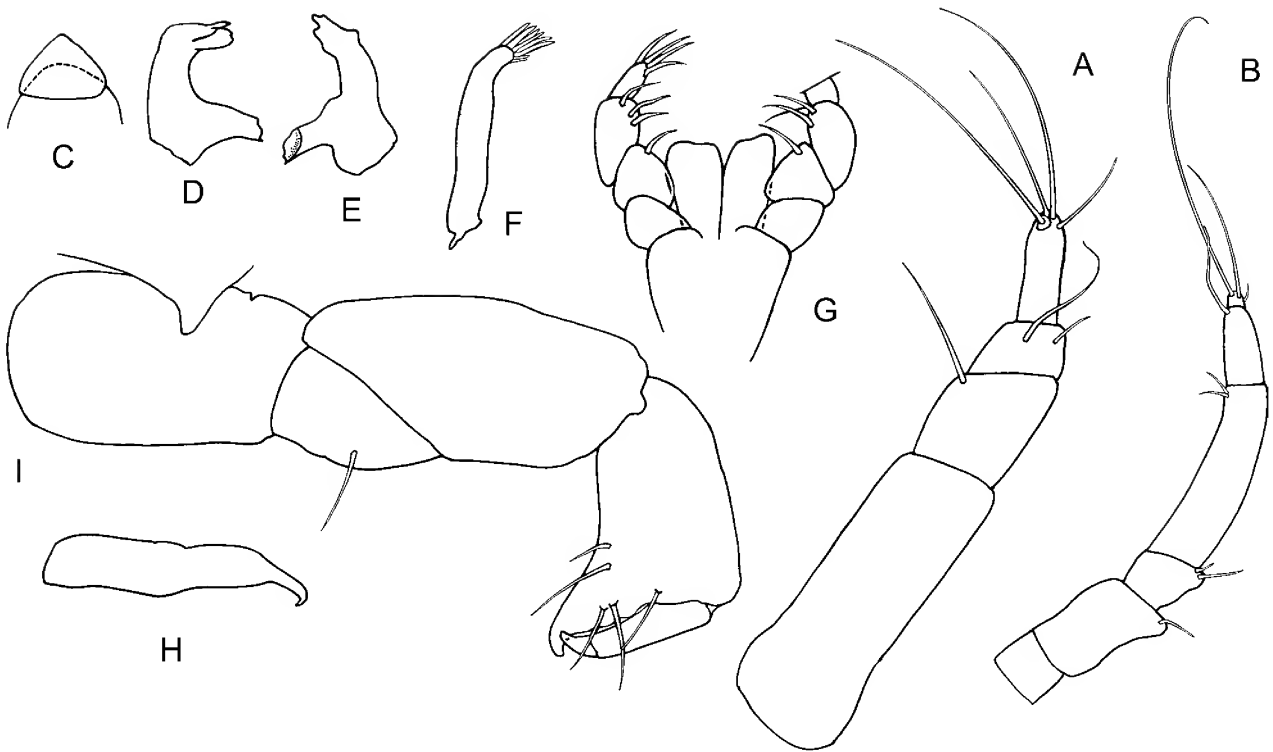
**Figure 4.** *Collettea elongata*. A. Female holotype, dorsal view. B. Same, lateral view. C. Male paratype, lateral view.

smooth. Article 2 as long as article 4, with 1 simple distal seta. Article 3 half as long as article 2, with 2 simple distal setae. Article 4 length nearly 3 times as long as article 3, with 3 simple distal setae. Article 5 minute and partly obscured under extension of article 4, with 1 simple seta.

Antenna. (Figure 5B) Length 4/5 of antennule. Article 1 quadrate, smooth. Article 2 length 2 1/2 times longer than article 3, with 1 simple distal seta. Article 3 length 1/4 the length of article 4, with 2 distal setae. Article 4 longer than 2 preceding articles combined, with

2 simple distal setae. Article 5 length 2/3 article 2, with 1 distal simple seta. Article 6 minute with 3 distal setae.

Mouthparts. Labrum (Figure 5C) hood shaped, smooth. Labium not recovered. Mandible molar process longer than incisor and relatively broad. Left mandible (Figure 5D) lacinia mobilis broad and larger than incisor; incisor with 2 denticles. Right mandible (Figure 5E) incisor with 3 distal denticles and 1 posterior denticle. Maxillule (Figure 5F) endite with 8 spiniform distal setae. Palp not recovered. Maxilla not recovered. Maxil-



**Figure 5.** *Collettea elongata*, female. A. Antennule. B. Antenna. C. Labrum. D. Left mandible. E. Right mandible. F. Maxillule. G. Maxilliped. H. Epignath. I. Cheliped.

liped (Figure 5G) endites smooth. Palp article 1 smooth. Article 2 with 1 thick seta. Article 3 with 3 thick setae. Article 4 with 4 thick distal setae. Epignath (Figure 5H) as long as maxillule endite, smooth and with hook-shaped apex.

Cheliped. (Figure 5I) Basis divided unequally by sclerite, shorter than carpus. Merus triangular with 1 ventral seta. Carpus longer than propodus including fixed finger, smooth. Propodus with 1 simple seta at dactylus insertion. Fixed finger without serrations, with 2 ventral setae and 2 on inner margin. Dactylus smooth.

Pereopod 1. (Figure 6A) Coxa with 1 simple seta. Basis longer than 3 succeeding articles together, smooth. Ischium with 1 simple seta. Merus shorter than carpus, widening distally and smooth. Carpus shorter than dactylus, smooth. Propodus 2/3 as long as basis, with 1 simple, dorsal distal seta and 1 dorsal distal spine. Dactylus and terminal seta shorter than propodus.

Pereopod 2. (Figure 6B) as pereopod 1 except coxa and ischium smooth. Merus and carpus with 1 simple distal seta. Propodus with 1 simple, ventral distal seta and 1 dorsal spine.

Pereopod 3. (Figure 6C) As pereopod 2 except carpus with 2 simple distal setae.

Pereopod 4. (Figure 6D) As pereopod 3 except merus with 1 simple and 1 thick distal seta. Carpus with 4 thick and 1 simple distal seta. Propodus as long as

carpus, with 3 simple distal setae. Dactylus and terminal seta longer than propodus.

Pereopod 5. (Figure 6E) As pereopod 4 except ischium with 1 simple seta. Carpus with 3 thick and 1 simple distal seta.

Pereopod 6. (Figure 6F) As pereopod 4 except merus with 3 distal setae. Carpus with 3 distal setae. Propodus with 4 dorsal and 1 ventral distal seta.

Pleopods. No pleopods on female.

Uropods. (Figure 6G) Protropod smooth. Endopod with 2 articles; article 1 longer than article 2, smooth; article 2 with 5 long, simple distal setae. Exopod about 1/2 as long as endopod article 1, with 2 simple distal setae.

**Description.** Adult male (when different from female).

Body. (Figure 4C) 13 times longer than broad.

Cephalothorax. Shorter than combined length of pereonite 1 and 2.

Pleon. Pleonites longer than female pleopods. Pleotelson shorter than combined length of 3 pleonites.

Mouthparts. Left mandible (Figure 7D) incisor with more denticles than female

Pleopods. (Figure 7O) Protropod smooth. Endopod rectangular, with 6 simple distal setae. Exopod rectangular, with 8 simple distal setae.

**Remarks.** This species was one of a large number of filiform species found in the deep-sea Gulf samples. The



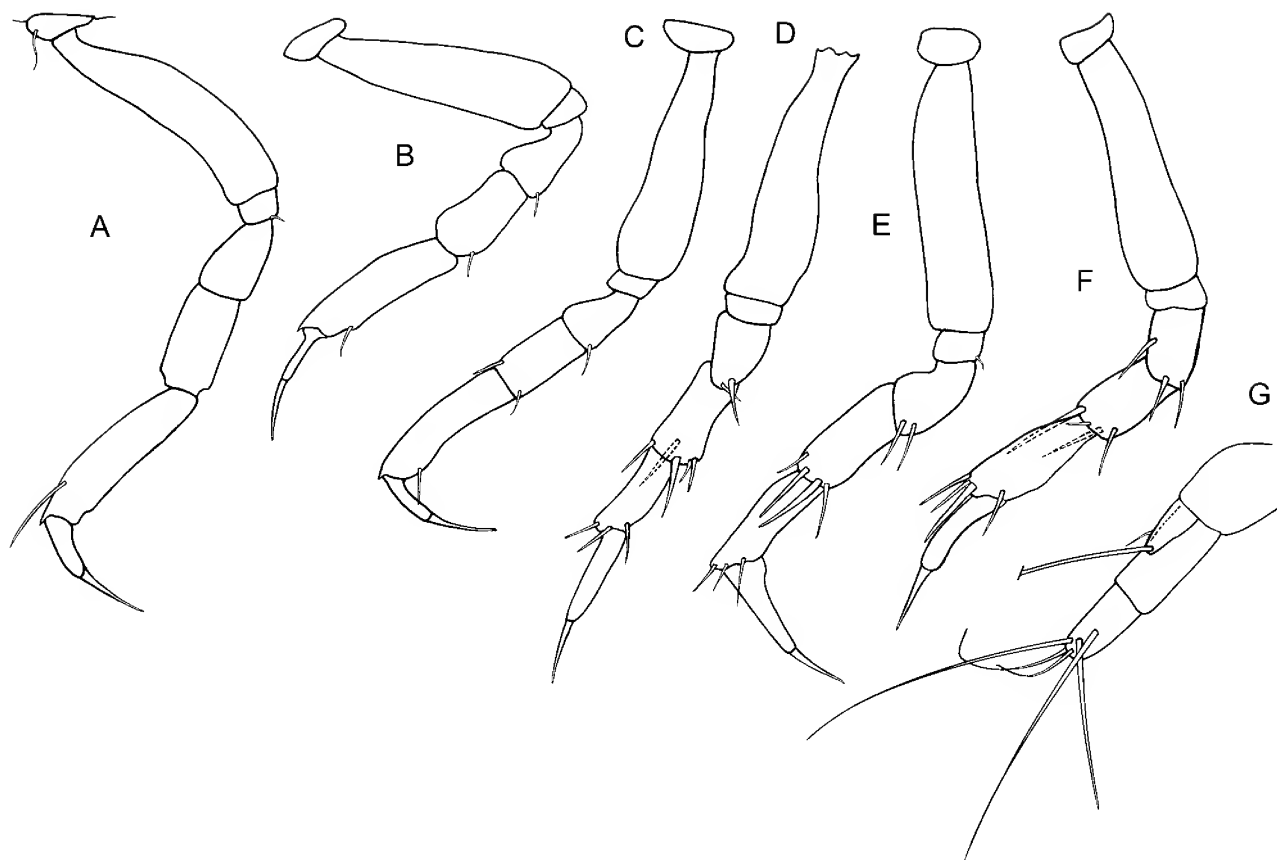


Figure 6. *Collettea elongata*, female. A. Pereopod 1. B. Pereopod 2. C. Pereopod 3. D. Pereopod 4. E. Pereopod 5. F. Pereopod 6. G. Uropod.

filiform body-shape does not appear to belong to one natural group; a large number of different evolutionary lines seem to be present (Larsen, research in progress), all having adapted to this niche by turning "worm-like". The difference in length of pleonites in the 2 sexes is puzzling and it cannot be excluded that a "colletteid" species complex of small elongate forms exists.

*Paragathotanaia* Lang, 1971

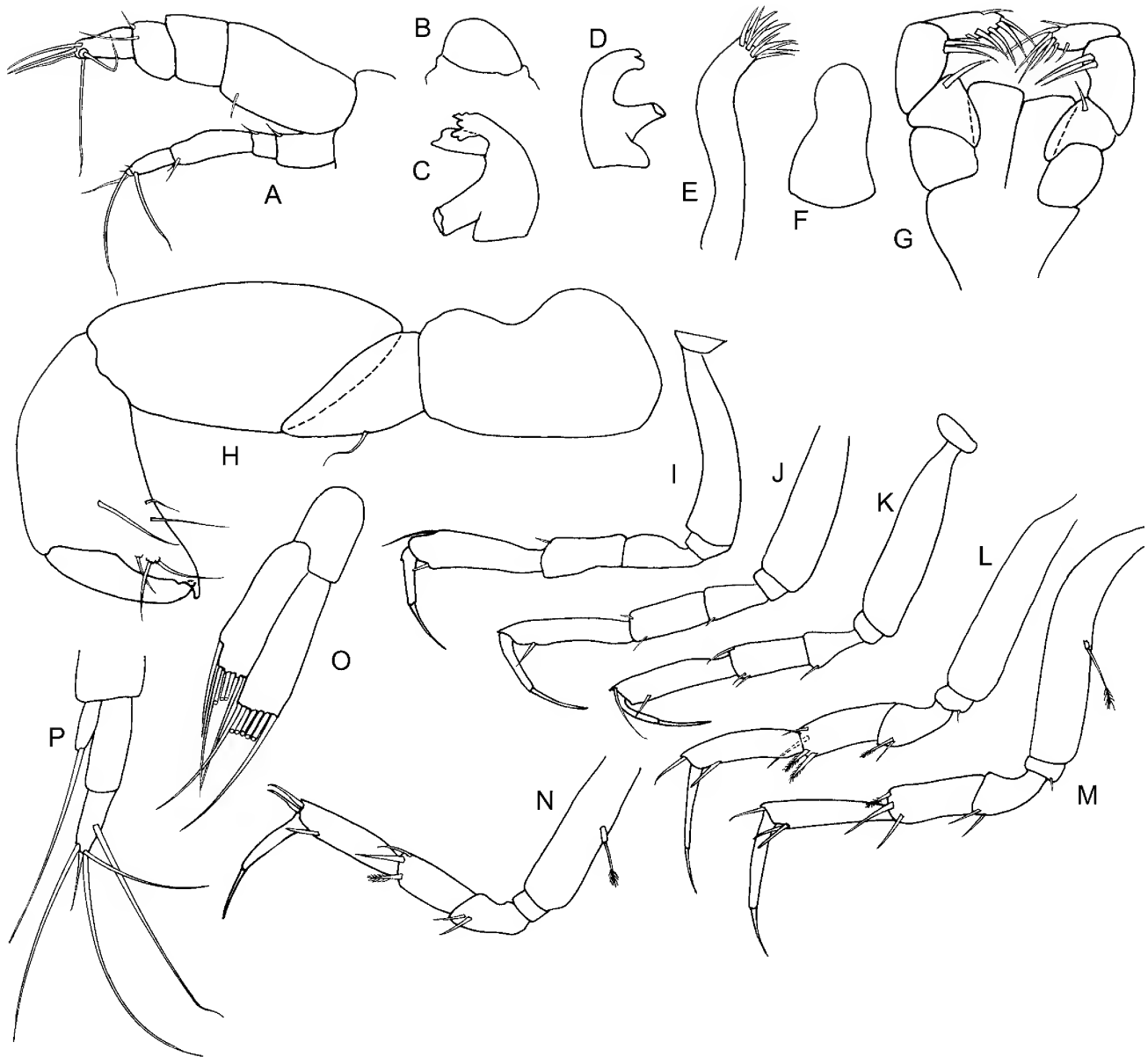
**Diagnosis.** (modified after Lang, 1971 and Bird and Holdich, 1988) Female: Antennule with 4 articles. Antenna with 4–6 articles. Mandibles with posteriorly directed pointed molar; lacinia mobilis of left mandible spiniform. Maxillule with 10–11 terminal spiniform setae. Labium with distal processes. Epignath without terminal spine. Cheliped attached with or without pseudocoxa to ventral surface of cephalothorax. Pereopods with coxae. Pleon with 5 free pleonites. Pleonites narrower than pereonites and pleotelson. Uropodal protopod not fused with uniarticulated endopod; exopod reduced to a minute projection, giving rise to one or more setae. Pleotelson with dorsal distal plate. Male: Anten-

nule thicker than that of female. Mouthparts resemble, but are not identical to those, of females; maxillule with fewer terminal spiniform setae. Labium with less pronounced distal processes. Pleopods with simple setae present on all pleonites. Pleonites as thick as other somites.

*P. medius* sp. nov. (Figures 8–9)

**Material examined.**—1 non-ovigerous female holotype, body length 1.8 mm. Station C7-2. 30 May 00. 27°43.9713'N, 89°58.6211'W. Depth 1070 m.—Paratypes: 1 non-ovigerous female and 1 male. Same locality.

**Other material.**—5 non-ovigerous females. Station C7-1. 30 May 00. 27°43.6967'N, 89°58.7782'W. Depth 1980 m. 17 non-ovigerous females. Station MT3-1. 16 Jun 00. 28°13.2246'N, 89°29.7679'W. Depth 983 m.—1 non-ovigerous female. Station MT4-1. 15 Jun 00. 28°49.6198'N, 89°09.9526'W. Depth 1401 m.—5 non-ovigerous females. Station NB3-2. 08 May 00. 26°33.3912'N, 91°49.4653'W. Depth 1875 m.—3 non-ovigerous females. Station RW1-1. 23 May 00.



**Figure 7.** *Collettea elongata*, male. A. Antennule and Antenna. B. Labrum. C. Left mandible. D. Right mandible. E. Maxillule. F. Maxilla. G. Maxilliped. H. Cheliped. I. Pereopod 1. J. Pereopod 2. K. Pereopod 3. L. Pereopod 4. M. Pereopod 5. N. Pereopod 6. O. Pleopod. P. Uropod.

27°30.0242'N, 96°00.1437'W. Depth 213 m.—5 non-ovigerous females. Station RW1-2. 23 May 00. 27°29.9333'N, 96°00.2164'W. Depth 213 m.—5 non-ovigerous females. Station S37-1. 13 Jun 00. 28°33.4054'N, 87°45.7357'W. Depth 2388 m.—1 non-ovigerous female. Station S39-1. 06 Jun 00. 27°29.9500'N, 87°00.0849'W. Depth 3007 m.—6 non-ovigerous females. Station S42-1. 09 Jun 00. 28°15.1557'N, 86°25.0663'W. Depth 767 m.—3 non-ovigerous females. Station W2-1. 14 May 00. 27°24.8008'N, 93°20.2579'W. Depth 625 m.—1 non-ovigerous female. Station W2-2. 14 May 00. 27°24.7019'N, 93°20.3849'W. Depth 625 m.—1 non-

ovigerous female. Station W3-1. 14 May 00. 27°10.3711'N, 93°19.3081'W. Depth 860 m.—1 non-ovigerous female. Station W5-1. 16 May 00. 26°15.967'N, 93°21.680'W. Depth 2755 m.—1 non-ovigerous female. Station W12-1. 05 May 00. 27°19.3945'N, 91°33.3486'W. Depth 1168 m.—1 non-ovigerous female. Station B1-2. 06 May 00. 27°12.1374'N, 91°24.1806'W. Depth 2255 m.—2 non-ovigerous females. Station B3-2. 10 May 00. 26°09.7884'N, 91°43.9954'W. Depth 2580 m.—8 non-ovigerous females. Station C7-2. 30 May 00. 27°43.9713'N, 89°58.6211'W. Depth 1070 m.—1 non-ovigerous female. Station MT5-1. 03 Jun 00. 27°19.9308'N, 88°40.0690'W. Depth 2275 m.—4 non-

ovigerous females. Station NB2-2. 07 May 00. 27°08.2040'N, 91°59.9207'W. Depth 1530 m.—2 non-ovigerous females. Station NB4-2. 11 May 00. 26°14.9693'N, 92°23.4731'W. Depth 2050 m.—3 non-ovigerous females. Station NB5-2. 09 May 00. 26°15.0855'N, 91°12.7524'W. Depth 2060 m.—2 non-ovigerous females. Station S35-2. 11 Jun 00. 29°19.9897'N, 87°02.9021'W. Depth 667 m.—1 non-ovigerous female. Station S37-2. 13 Jun 00. 28°33.4292'N, 87°45.6441'W. Depth 2382 m.—3 non-ovigerous females. Station S42-2. 10 Jun 00. 28°15.1070'N, 86°25.0209'W. Depth 768 m.

**Diagnosis.** Antenna with 4 articles; article 3 with distal fusion line.

**Etymology.** Named to reflect that the structure of the antenna of this species is intermediate between that of *Agathotanais* and *Paragathotanais*, (Latin *medius* = intermediate).

**Description.** Adult female

Body. (Figures 8A, B) 6.5 times longer than broad.

Cephalothorax. Shorter than combined length of pereonite 1 and 2.

Pereonites. Pereonites with clearly defined shoulders. Pereonites 1, 2, and 6 wider than long. Pereonite 3 length subequal to width. Pereonites 4 and 5 longer than wide.

Pleonites. Narrower than pereonites and pleotelson.

Pleon. All pleonites subequal and lacking pleopods. Pleotelson with dorsal distal plate.

Antennule. (Figure 8E) Length shorter than cephalothorax. Article 1 longer than rest of antennule, with 1 simple and 3 sensory setae. Article 2 longer than article 3, with 1 simple distal seta. Article 3 longer than article 4, with 2 simple distal setae. Article 4 length 1/4 that of article 1, with 4 simple distal setae.

Antenna. (Figure 8F) With 4 articles. Marginally longer than antennule article 1. Article 1 twice as long as article 2, smooth. Article 2 square, smooth. Article 3 longer than combined length of other antenna articles, with distal fusion line, 1 distal and 2 simple subdistal setae. Article 4 minute with 2 distal setae.

Mouthparts. Labrum (Figure 8I) hood shaped, setose. Left mandible (Figure 8K) lacinia mobilis short and spiniform, incisor broad and bifurcate, molar apparently without denticles. Maxillule (Figure 8N) endite with 10 distal spiniform setae, palp not recovered. Maxilla not recovered. Maxilliped (Figure 8O) endites with uneven distal margin and no setae. Basis only marginally wider than endites. Palp article 1 smooth. Article 2 with 2 thick setae. Article 3 with 3 thick setae on inner margin. Article 4 with 4 thick distal setae. Epignath not recovered.

Cheliped. (Figure 9A) Basis divided into a pseudocoxa as long as basis proper. Merus triangular, with both ventral and dorsal margin visible, smooth. Carpus shorter than propodus, with 2 dorsal setae and 1 ventral seta. Propodus slender and smooth. Fixed finger with 1 distal process, 2 ventral setae and 3 on inner margin. Dactylus smooth.

Pereopod 1. (Figure 9B) Coxa smooth. Basis longer than 3 succeeding articles together, smooth. Ischium smooth. Merus shorter than carpus, widening distally, with 2 thick, simple ventral setae. Carpus shorter than propodus, rectangular, with 3 distal setae, 2 thick and 1 simple. Propodus longer than half of basis, with 1 simple seta on each margin and dorsal distal spine. Dactylus and terminal setae as long as propodus.

Pereopod 2. (Figure 9C) As pereopod 1 except ischium and merus with 1 simple seta. Carpus with 3 distal setae, 2 spiniform and 1 serrate. Propodus with 1 simple ventral seta and blunt dorsal spine.

Pereopod 3. (Figure 9D) As pereopod 1 except basis with 1 dorsal sensory seta. Propodus with 1 simple ventral seta and dorsal spine.

Pereopod 4. (Figure 9E) Basis not apparently wider than on pereopod 1–3, with 1 sensory seta, Ischium smooth. Merus with 2 simple distal setae, shorter than carpus. Carpus with 4 thick distal setae. Propodus with 4 distal setae, 3 thick and 1 thick, serrate; 1 dorsal spine. Dactylus and terminal seta, longer than propodus.

Pereopod 5. (Figure 9F) As pereopod 4 except basis with 2 sensory setae. Ischium with 1 ventral seta. Carpus with 3 thick distal seta.

Pereopod 6. (Figure 9G) As pereopod 5 except basis smooth. Carpus with 2 thick distal setae.

Pleopods. All pereonites lacking pleopods on female.

Uropods. (Figure 8U) Protopod less than 1/2 the length of article 2, with 0–1 simple distal seta. Endopod with 2 long distal setae.

**Description.** Adult male (when varying from female).

Body. (Figures 8C, D) Somewhat shorter than female.

Pereonites. Pereonites 1, 2, 3, and 6 wider than long. Pereonites 4 and 5 length subequal to width.

Pleonites. As wide as pereonites and pleotelson.

Antennule. (Figure 8G) With 5 articles. Article 1 shorter than rest of antennule, with 5 simple setae. Article 5 minute with 3 simple setae and 1 aesthetascs.

Mouthparts. Left mandible (Figure 8L) lacinia mobilis shorter than females. Incisor with more denticles than female. Maxillule (Figure 8M) endite with 8 spiniform distal setae.

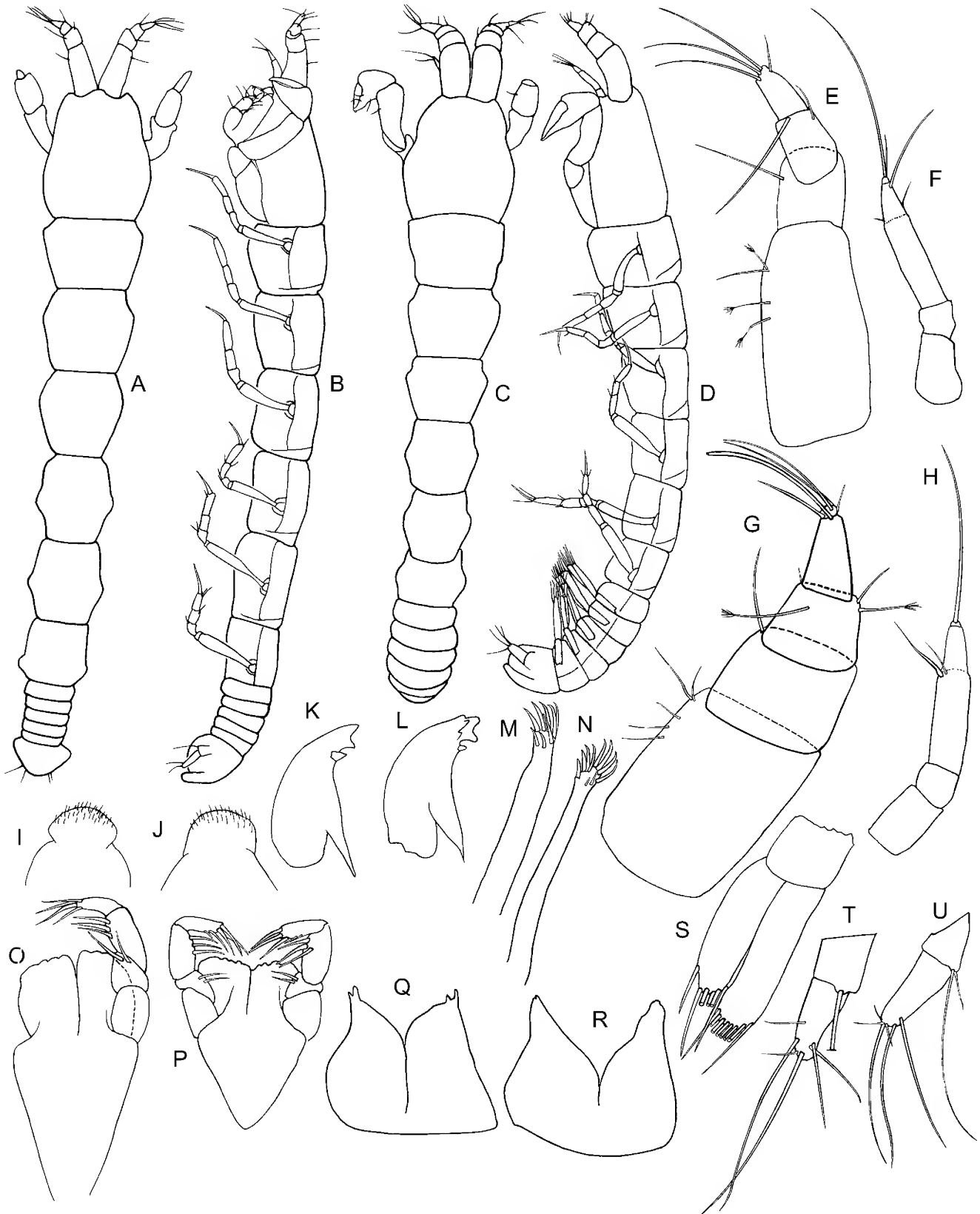


Figure 8. *Paragathotanis medius*. A. Female holotype, dorsal view. B. Same, lateral view. C. Male paratype, dorsal view. D. Same, lateral view. E. Female antennule. F. Female antenna. G. Male antennule. H. Male antenna. I. Female labrum. J. Male labrum. K. Female left mandible. L. Male left mandible. M. Male maxillule. N. Female maxillule. O. Female maxilliped. P. Male maxilliped. Q. Male labium. R. Female labium. S. Male pleopod. T. Male uropod. U. Female uropod.

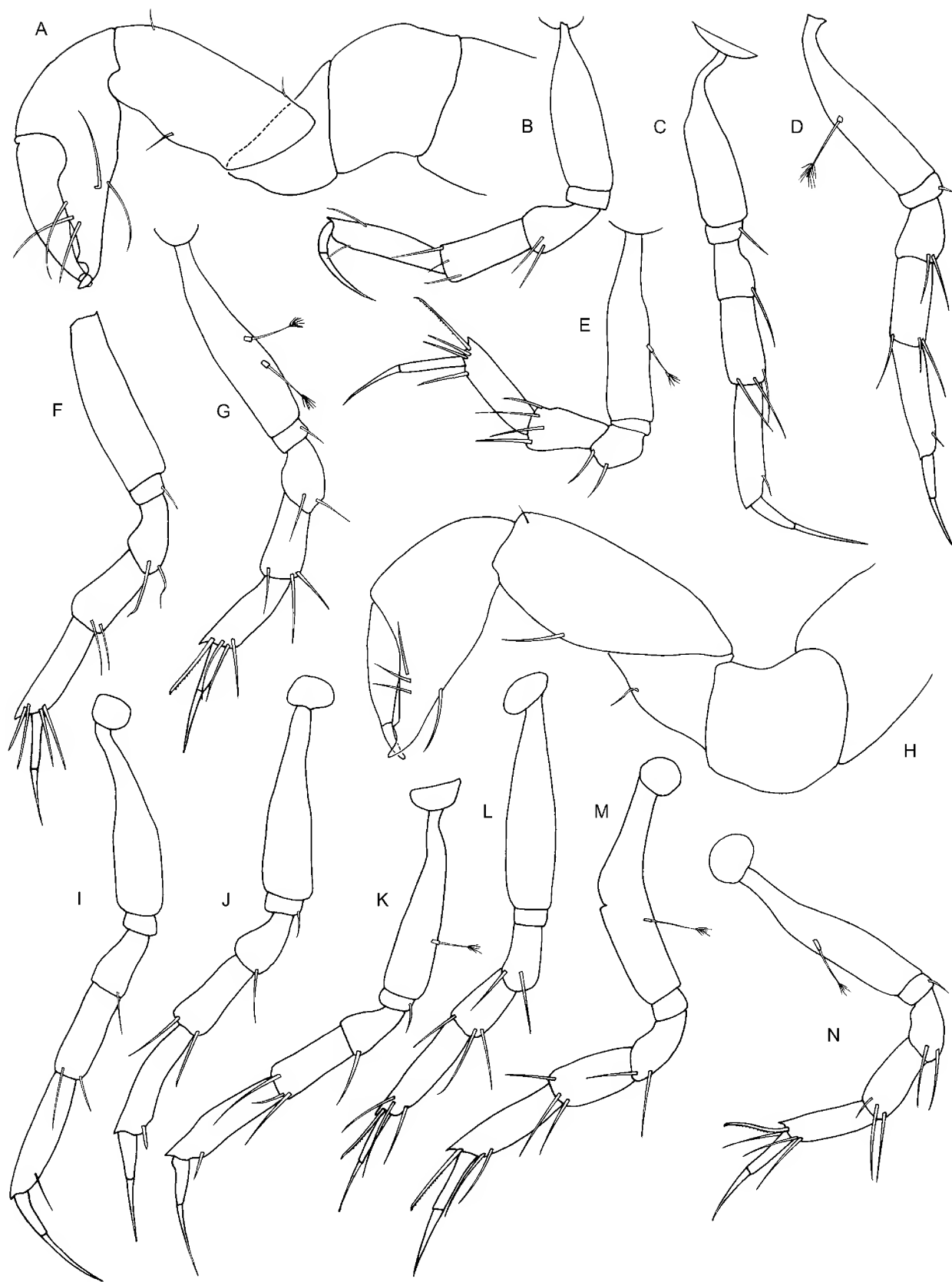


Figure 9. *Paragathotanus medius*. A-G female, H-N male. A. Cheliped. B. Pereopod 1. C. Pereopod 2. D. Pereopod 3. E. Pereopod 4. F. Pereopod 5. G. Pereopod 6. H. Cheliped. I. Pereopod 1. J. Pereopod 2. K. Pereopod 3. L. Pereopod 4. M. Pereopod 5. N. Pereopod 6.

Cheliped. (Figure 9H) Fixed finger with 1 ventral seta.

Pereopods. (Figures 9I–N) Generally similar to female.

Pleopods. (Figure 8S) Protopod square and smooth. Endopod and exopod armed with 6 and 8 simple distal setae respectively.

**Remarks.** Besides the reduced antenna, *P. merus* also displays a cheliped with pseudocoxa, a feature not found in other species of *Paragathotanaeis*. This finding is most surprising and cannot be explained at this time.

#### KEY TO *PARAGATHOTANAIS*

1. Antenna article 2 with spinules ..... *P. gracilis*  
     Antenna article 2 without spinules ..... 2
2. Cheliped stout (length-width ratio of carpus 1.5) ....  
     ..... 3  
     Cheliped slender (length-width ratio of carpus 2.3)  
     ..... 4
3. Pleotelson apex smoothly rounded. Cheliped fixed finger with 2 processes. Cheliped dactylus with 2 short spiniform setae ..... *P. nanus*  
     Pleotelson apex pointed. Cheliped fixed finger with 1 process. Cheliped dactylus without 2 short spiniform setae ..... *P. macrocephalus*
4. Antenna with 4 articles. Labium without lateral setae. Cheliped with pseudocoxa ..... *P. medius*  
     Antenna with 5 or more articles. Labium with lateral setae. Cheliped without pseudocoxa ..... 5
5. Maxillule palp article 3 with inner spine. Cheliped dactylus with 1 short spiniform seta ..... *P. typicus*  
     Maxillule palp article 3 without inner spine. Cheliped dactylus with 2 short spiniform setae ..... *P. robustus*

#### ACKNOWLEDGMENTS

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# **TANAPSEUDES GUTUI, A NEW SPECIES OF APSEUDOMORPHAN TANAIIDACEA (CRUSTACEA: PERACARIDA) FROM THE CARIBBEAN SEA AND THE TAXONOMIC STATUS OF THE FAMILY TANAPSEUDIDAE BĂCESCU, 1978**

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**ABSTRACT** *Tanapseudes gutui*, n. sp., is described from depths of 3–34 m off San Juan, Puerto Rico, and 4–5 m off Goat Island, Tobago. *Tanapseudes sinensis* Bamber from Hong Kong waters is re-examined and determined to represent a junior synonym of the type species *T. ormuzana* Băcescu which was originally collected in the Straights of Hormuz off Iran. *Tanapseudes gutui* can be distinguished from *T. ormuzana* by several characters including details of the mouth parts, the presence of a reduced spiniform seta on the distotergal margin of the propodus of pereopod 1, pereonites 3–6 with rounded anterior margins, and a pleotelson lacking a mid-lateral lobe. A neotype is established for *T. ormuzana* based on a specimen collected from near the original type locality, and its mouth parts and pereopod 1 are illustrated. Largely based on the absence of a palp on the maxillule and the presence of a bifurcate seta on the dactyl of pereopod 1, the family Tanapseudidae Băcescu is now considered a subfamily within the family Kalliapseudidae Lang *sensu* Guțu. The genus *Paradoxapseudes* Guțu, formerly within the family Tanapseudidae *sensu* Guțu, is tentatively transferred to the family Apseudidae Leach.

## **INTRODUCTION**

The apparent absence of the inner antennular flagellum led Băcescu (1978) to create the monotypic family Tanapseudidae Băcescu to receive *Tanapseudes ormuzana* Băcescu, 1978. His description was based on two adult specimens, a female (holotype) and a male (paratype) collected from the Ormuz Straights (eastern Persian Gulf). A second monotypic genus, *Paradoxapseudes* Guțu, 1991 (type species: *P. cubensis*), described from Cuban waters, was placed in the family by Guțu (1991). Bamber (2000) described a second species of *Tanapseudes* Băcescu, 1978, *T. sinensis* Bamber, 2000 from off Hong Kong. He reduced the family Tanapseudidae to a subfamily within the family Sphyrapidae Guțu, 1980 and indicated that the family status of *Paradoxapseudes* was uncertain, but that the genus was not referable to the Sphyrapidae.

During the examination of Tanaidacea collected from the near-shore waters of Puerto Rico and Tobago, we discovered a small apseudomorphan with a vestigial, uniarticulate, inner antennular flagellum. Except for the absence of a maxillular palp and the presence of a bifurcate seta on the dactyl of the first pereopod, the new species appeared to be very similar to the two described species of *Tanapseudes*: *T. ormuzana* and *T. sinensis*.

Unfortunately, the type material of *T. ormuzana* is lost (M. Guțu, personal communication, “Grigore Antipa” National Museum of Natural History, Bucharest, Romania); however, we have located in the collections of the Natural History Museum, London, two specimens referable to *T. ormuzana* from near the type locality. In this paper we describe the new Caribbean species of *Tanapseudes*, re-examine *T. ormuzana* and *T. sinensis*, and present observations on the systematic and taxonomic status of *Tanapseudes* and the family Tanapseudidae.

Type material has been deposited in the National Museum of Natural History, Washington, DC, USA (USNM); the Natural History Museum, London, UK (NHM), the Gulf Coast Research Laboratory Museum, Ocean Springs, MS, USA (GCRL), and “Grigore Antipa” National Museum of Natural History, Bucharest, Romania (MNINGA). Other abbreviations used are: EPA for US Environmental Protection Agency, TL for total length (tip of rostrum to tip of pleotelson), CL for carapace length (tip of rostrum to mid-dorsal posterior margin). In this report we follow Bamber (2000) in designating the thoracic appendage (fossorial leg) on the first unfused pereonite as pereopod 1.



## RESULTS

**Tanaidacea Dana, 1849**  
**Apseudomorpha Sieg, 1980**  
**Kalliapseudidae Lang, 1956**  
**Tanapseudinae Băcescu, 1978**  
***Tanapseudes* Băcescu, 1978**

**Type species.** *Tanapseudes ormuzana* Băcescu, 1978

**Synonym.** *T. sinensis* Bamber, 2000

**Other species.** *Tanapseudes gutui*, n. sp.

**Revised diagnosis.** Body small, length less than 3 mm, lacking hyposphenia. Carapace without eyes. Rostrum rounded. Antennule with vestigial, uniarticulate inner flagellum. Mandibular palp uniarticulate. Maxillule lacking palp. Cheliped and pereopod 1 lacking exopods. Cheliped sexually dimorphic with female fixed finger triangular and shortened. Male with “hammer-shaped” cheliped. Pereopod 1 with a bifurcate seta on outer margin of dactylus. Pereonites 3–5 with glandular-like clusters. Oostegites, 4 pairs on pereonites 2–5. Pleopods 5 pairs.

**Taxonomic and systematic remarks.** Based on an examination of two male specimens attributable to *T. ormuzana* from the eastern Persian Gulf near the Straits of Hormuz, we have determined that the genus is characterized by: 1) a uniarticulate mandibular palp with long terminal seta, 2) no maxillular palp, 3) a bifurcate seta on the dactyl of the first pereopod, and 4) apparent glandular areas on the body and pereopods.

Bamber (2000) reassigned *Tanapseudes* to the family Sphyrapidae based on the original description of *T. ormuzana* and on the observed morphology of *T. sinensis*, but he also pointed out a number of morphological features that are consistent with the kalliapseudid genus *Psammokalliapseudes*. Although *Tanapseudes* had not been reported to have bifurcate “sensory” setae on the dactyl of the first pereopod, he suggested that the Kalliapseudidae and Sphyrapidae may be closely allied.

Following the discovery that the Caribbean species lacked a maxillular palp and had a small bifurcate seta on the dactyl of pereopod 1, the type material of *T. sinensis* was reexamined. The holotype was found to lack a true maxillular palp and to possess a similar bifurcate dactylar seta (Figure 1J). This minute seta can be easily overlooked, and its tip is broken off on both dactyls of first pereopods on the “allotop.” An examination of the material of *T. ormuzana* from the Persian Gulf also revealed the presence of this small bifurcate seta on the dactyl of pereopod 1 and the absence of a maxillular palp. Since Bamber excluded *Tanapseudes* from the

Kalliapseudidae only because these two features were supposedly absent, we herein reassign the subfamily Tanapseudinae to the Kalliapseudidae sensu Guțu (1972, 1996).

*Tanapseudes* is distinguished from all other kalliapseudid genera by having the inner antennular flagellum reduced to a single small article. We thus follow Bamber and retain the subfamily Tanapseudinae to accommodate this apparently highly derived genus. The body forms of genera belonging to the Hemikalliapseudinae Guțu, 1972 (*Bacescapseudes* Guțu, 1981; *Hemikalliapseudes* Lang, 1956; *Paraleiopus* Brum, 1978) are superficially similar, but members of this subfamily have a mandibular palp composed of 3 articles and an exopod on the first pereopod, unlike the species of *Tanapseudes*, which have an uniarticulate palp and pereopod 1 without an exopod.

*Tanapseudes* appears to be intermediate between *Kalliapseudes* Stebbing, 1909 and *Psammokalliapseudes* Lang, 1956. As in the genus *Kalliapseudes sensu lato*, the outer margin of the mandibular palp of *Tanapseudes* bears a row of dense setae, but they are not long nor modified for filtering. In other respects, *Tanapseudes* resembles the genus *Psammokalliapseudes* as follows: 1) the antennal peduncle is sparsely setose, 2) chelipeds lack a row of long plumose setae along the carpus, and 3) dactyl of pereopod 1 bears a small bifurcate seta. This bifurcate or “sensory seta” is, however, unlike those of *Kalliapseudes* and *Psammokalliapseudes*, which bear numerous curls bundled together with a single stalk-like base.

Besides *Tanapseudes ormuzana* (= *T. sinensis*), and the new species described herein from the tropical northwestern Atlantic, only two other apseudomorph species, *Sphyrapus maleollus* Norman and Stebbing, 1886 and *Paradoxapseudes cubensis* Guțu, 1991, are known currently to lack or have a vestigial accessory antennular flagellum. Bamber considered that the monotypic genus *Paradoxapseudes* was systematically far removed from *Tanapseudes*. We tentatively assign *Paradoxapseudes* to the family Apseudidae Leach, 1814. The only major character distinguishing it from other apseudids is the apparent absence or great reduction of the accessory flagellum of the antennule, which, as previously mentioned, is an apparently highly derived condition that also has occurred independently within the families Kalliapseudidae and Sphyrapidae.

As suggested by Bamber, the families Kalliapseudidae and Sphyrapidae may be related. They share one important condition unknown in any other families of the order: at least some kalliapseudid and sphyrapid genera bear exopods on the fourth and fifth

legs in the manca (Lang 1956, Guțu 1981, M. Guțu, R. Heard, and T. Hansknecht, personal observations). These two segmented exopods were also found in the brood pouch mancae of *Tanapseudes gutui* (present study). Whether this apparently plesiomorphic condition has been retained, or these two families are much more closely related than previously thought, awaits a study of their molecular systematics.

***Tanapseudes ormuzana* Băcescu, 1978**

Figures 1A–J

**Material examined.** Neotype male, NHM 2001.6823, Station 58, Persian Gulf, 26°45'N, 52°13'E, depth 63 m.—1 male, NHM 2001.6824, Station 28, Persian Gulf, 26°46'N, 52°19'E, depth 69.3 m.

*Tanapseudes sinensis* Bamber, 2000: holotype male, NHM 1998.2550, allotype female (NHM 1998.2551), Tai Tam Bay, Hong Kong, ca 22°13'N, 114°14'E, July 1993; 10–30 m depth, mud to muddy sand.

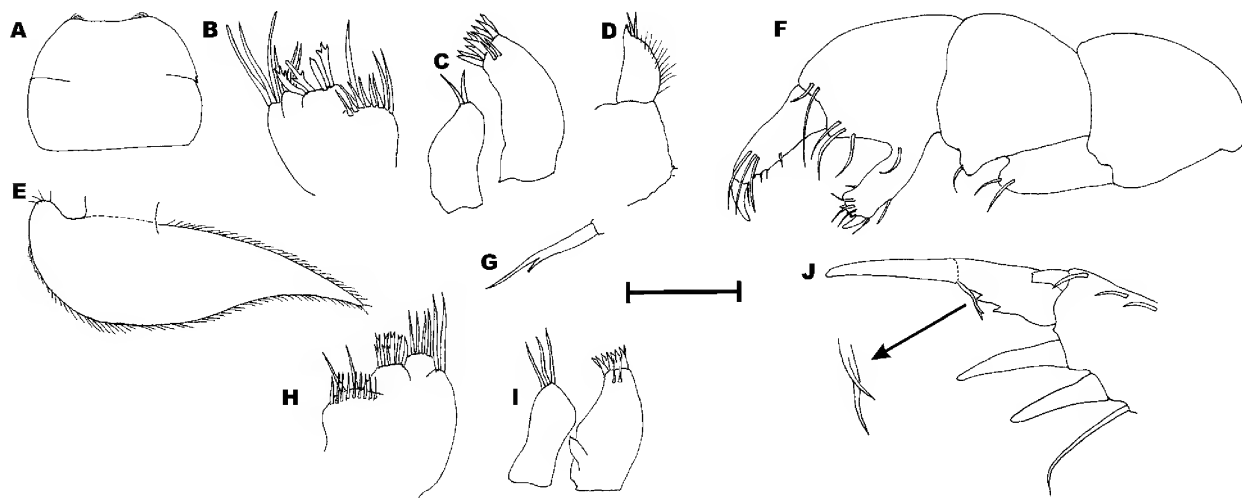
**Supplemental description.** Accessory flagellum of antennule represented by small tubercle bearing 3 setae. Antenna with squama bearing 2 distal setae. Mouthparts (based on dissection of a male from the Persian Gulf and paratype of *T. sinensis*). Cheliped having carpus with sternal apophysis in larger males (adjacent to distal extension of merus, giving appearance of notch as described by Băcescu, 1978). Pleopods well-developed, with basis bearing 2 plumose setae.

Mandible (as figured by Bamber 2000: Figure 4E) having palp uniaarticulate with long terminal seta, inner

margin with dense row of fine setae, outer margin lacking setae.

Labium (Figure 1D) with palp having 1 (Hong Kong: Bamber, 2000: Figure 4F) or 2 subdistal setae and a distal projection. Maxillule (Figures 1C, I) with inner endite (lobe) bearing 2–3 terminal setae; outer fixed endite with 8–9 short, spiniform terminal setae and 2 simple subterminal setae. Palp absent. Maxilla (Figures 1B, H) with inner rostral margin having row of 6 setae in Persian Gulf specimen and 4 setae in Hong Kong specimen respectively. Epignath (Figure 1E) slender, entire margin finely setose. Distal seta on dactyl of pereopod 1 minutely bifurcate (Figure 1G). For other morphological aspects of the species see Bamber (2000: p. 45–49).

**Remarks.** In the absence of the type material of *T. ormuzana*, Bamber distinguished *T. sinensis* by comparison with the original description and figures of Băcescu (1978) which indicated: 1) no accessory or inner flagellum on the antennule, 2) 3 articles on the main or outer flagellum of the antennule, 3) 4 setae on the squama of the antenna, 4) a short inner spine on article 4 of antennal peduncle, and 5) no setae on the basis of the pleopod. The two specimens from the Persian Gulf have an antennule with a small accessory flagellum, 3 articles on the outer flagellum, 2 setae on the squama of the antennae, no inner spine on the fourth peduncular antenna article, and 2 plumose setae on the pleopod basis. The antennular accessory flagellum and the 3 outer antennal flagellar articles are identical to those depicted in Figures 4B, C of Bamber (2000) for *T. sinensis*.



**Figure 1.** *Tanapseudes ormuzana* (Neotype), adult male: (A–G): (A) labrum; (B) maxilla; (C) maxillule; (D) labium; (E) epignath; (F) cheliped, left; (G) sensory seta pereopod 1. *Tanapseudes ormuzana* (Hong Kong), adult female (H–J): (H) maxilla; (I) maxillule; (J) pereopod 1 with sensory seta. Scales = 0.1 mm (A–F, H, I); 0.02 mm (G); 0.05 mm (J).

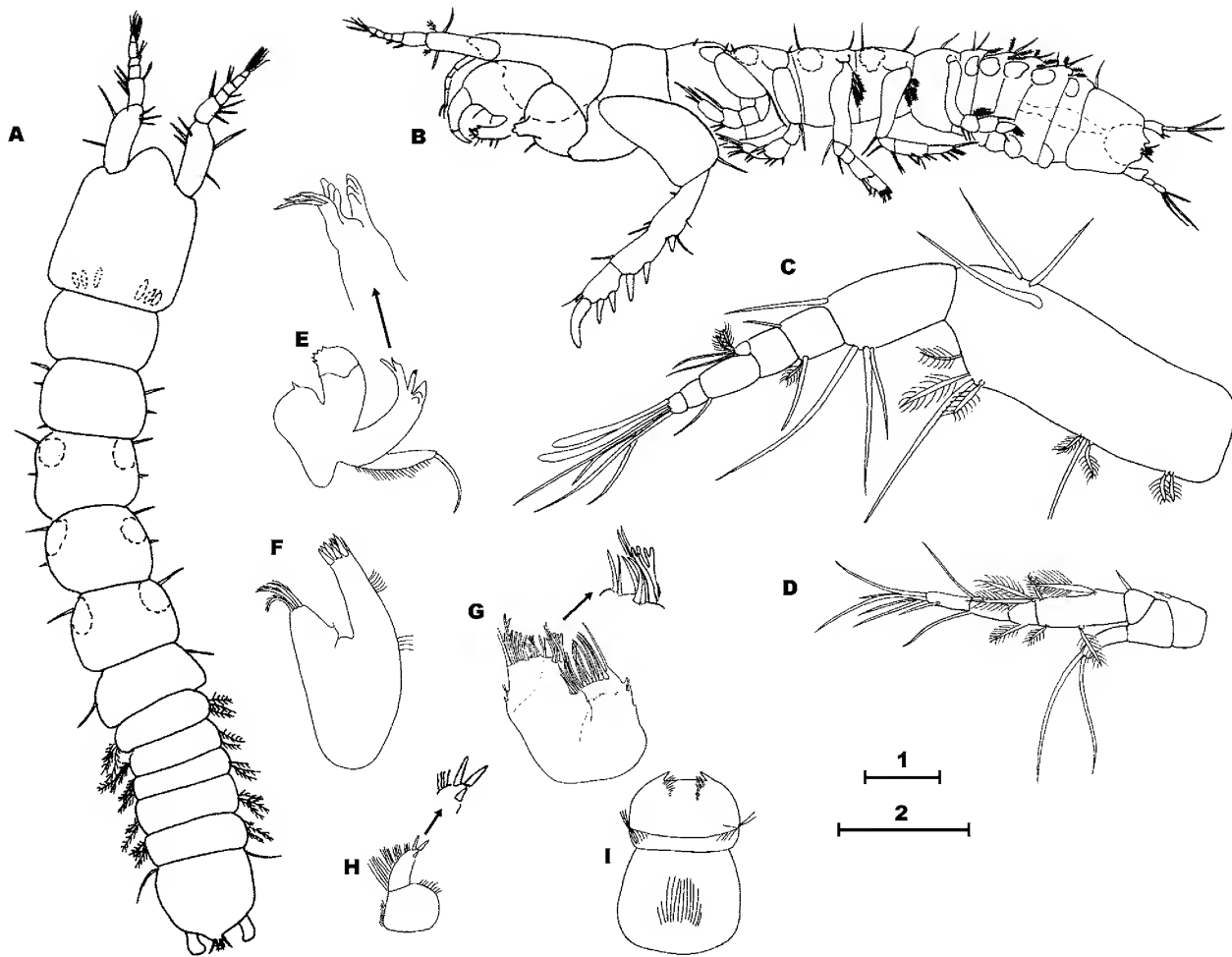


Figure 2. *Tanapseudes gutui* n. sp., adult male: (A) dorsal view; (B) lateral/ventrolateral aspect; (C) antennule; (D) antenna; (E) left mandible with enlargement of pars incisiva showing lacinia; (F) maxillule; (G) maxilla, with enlargement of middle endite; (H) labium; (I) labrum. Scale 1 = 0.2 mm (A, B); Scale 2 = 0.1 mm (C–I).

Except for the better developed sternal apophysis on the carpus of the cheliped (Bamber: Figures 1F, 5A), no significant differences could be found between the Persian Gulf specimens and type material of *Tanapseudes sinensis*. The possibility that *T. sinensis* occurs both off Hong Kong and sympatrically with *T. ormuzana* in the Persian Gulf is not likely; instead, we conclude that the original description of *T. ormuzana* was erroneous in some details and that these two species should be synonymized. We herein designate the male from the Persian Gulf (close to the type locality), which has an attached antennule, as the neotype of *T. ormuzana* (NHM 2001.6823).

Bamber's figures for *T. sinensis* are entirely appropriate for *T. ormuzana*. In addition, circular clusters of glandular tissue were observed at the anterolateral corners of pereonites 3 and 4 (Persian Gulf specimens) or 3 to 5 (Hong Kong specimens).

#### *Tanapseudes gutui*, n. sp.

Figures 2, 3

**Material examined.** Holotype.—Adult male, TL 2.2 mm, CL 0.54 mm, USNM 1001787, CH2M HILL Carolina Waste Water Treatment Plant (WWTP), Puerto Rico, Station C1-2, 18°27.797'N, 65°53.439'W, 30 October 1999, depth 34 m, sandy clay.

Paratypes. Puerto Rico: 2 males, 1 ovigerous female, USNM 1001788, same data as holotype; 1 male, 1 ovigerous female, GCRL 2038, CH2M HILL Carolina WWTP, Station C1-3, 18°27.797'N, 65°53.439'W, 30 October 1999 depth 34 m, sandy clay; 1 male (dissected) MNINGA 250.181, 2 ovigerous MNINGA 250.180; 1 male NHM 2001.6903, 1 female NHM 2001.6904, EPA, Puerto Rico, Station PR-44, 17°57.80'N, 66°21.68'W, 4 August 2000, depth 3 m, sandy mud.

**Additional material.** Puerto Rico: 2 males, 9 females (7 ovigerous), EPA, Station PR-44, 17°57.80'N,

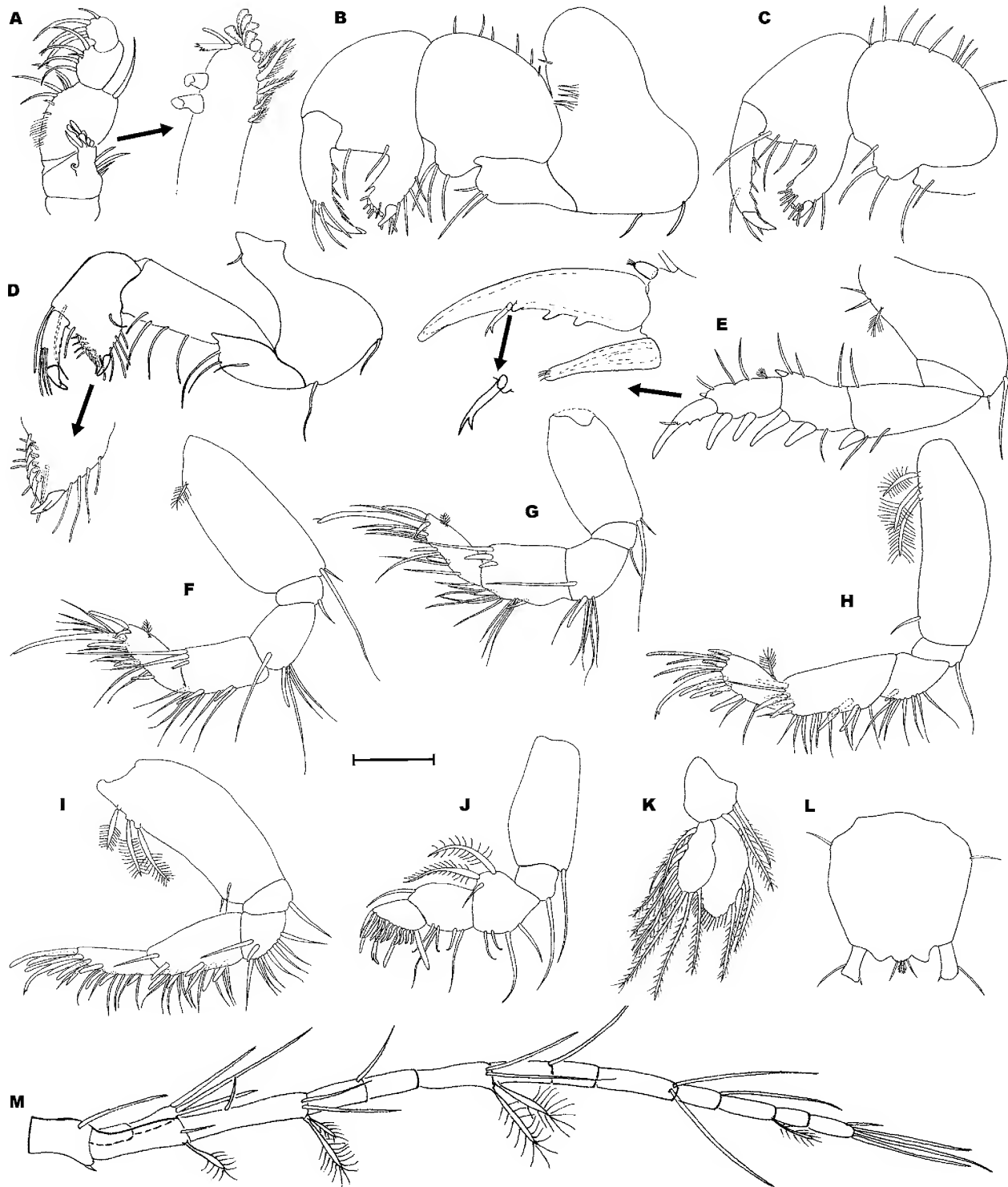


Figure 3. *Tanapseudes gutui* n. sp.: (A) maxilliped with enlargement of endite; (B) male cheliped, lateral aspect; (C) same, inner aspect; (D) female cheliped, lateral view with enlargement of propodal fixed finger; (E–J) male pereopods 1–6, respectively, pereopod 1 with enlargement of dactylus; (K) male pleopod 2; (L) male pleotelson; (M) uropod, inner aspect. Scales = 0.1 mm (A–L); 0.5 mm (M).

66°21.68'W, 4 August 2000, depth 3 m, sandy mud. CH2M HILL Carolina WWTP: 1 male, 3 ovigerous females, Station C5-1, 18°27.70'N, 65°52.24'W, 11 July 1999, depth 24 m.—3 spec., Station C5-2, 18°27.70'N, 65°52.24'W, 23 April 1999, depth 25 m.—2 spec., Station C5-1, 18°27.70'N, 65°52.24'W, 11 July 1999, depth 24 m.—1 male, 3 ovigerous females, Station C5-2, 18°27.70'N, 65°52.24'W, 11 July 1999, depth 24 m.—2 spec., Station C1-1, 18°27.797'N, 65°53.439'W, 30 October 1999, depth 34 m, sandy clay.—5 males, 3 ovigerous females, 11 subadults, Station C1-2, 18°27.797'N, 65°53.439'W, 30 October 1999, depth 34 m, sandy clay.—1 spec., Station C1-3, 18°27.797'N, 65°53.439'W, 30 October 1999, depth 34 m, sandy clay.—3 spec., Station C3-3, 18°27.729'N, 65°53.092'W, 30 October 1999 30 m, clayey sand.—13 spec., Station C6-2, 18°27.739'N, 65°53.399'W, 30 October 1999, depth 33 m, sandy gravel.—1 spec., Station C6-3, 18°27.739'N, 65°53.399'W, 30 October 1999, depth 33 m, sandy gravel.

Tobago: 3 males, 7 females (2 ovigerous), 1 subadult male, Goat Island, 11°15'N, 60°30'W, 14 January 93, depth 4–5 m, sand, collected by R.W. Heard, handheld suction pump.

**Diagnosis.** Pereopod 1 with spiniform seta (with distal setule) on distotergal (extensor) margin of propodus reduced, length less than one fifth of dactylus; pereonites 4–6 with rounded anterolateral margins. Cheliped of mature male with tooth on dactylus. Pleotelson with lateral margins entire.

**Description.** Adult male (Figure 2A, B). TL 2.2 mm. Hyposphenia absent.

Carapace approximately 1.2 times longer than wide, slightly longer than combined lengths of first 2 pereonites; rostrum wider than long, rounded anteriorly, not extending beyond midpoint of first peduncular article of antennule; eye lobes weakly developed, eyes absent.

Pereon with all 6 free pereonites wider than long, rounded laterally; 2–4 with several lateral setae; 3, 4, and 5 largest with paired glands evident on anterolateral margins after staining with Rose Bengal (Figure 2A).

Pleon (Figure 1A) with all 5 pleonites much wider than long, with paired plumose setae on lateral margins.

Pleotelson (Figure 3L) nearly as wide as long, entire; lateral margins smooth, rounded.

Antennule (Figure 2C) with peduncle having 4 articles; article 1 large, longer than other articles combined. Outer flagellum with 3 articles; article 1 longer than 2 and 3 combined; article 3 terminating with 4 simple setae and with 2 subterminal linguiform aesthetascs on inner margin. Inner flagellum vestigial,

represented by single reduced, nub-like article bearing 1 pair of broom and 1 pair of simple setae distally.

Antenna (Figure 2D). Peduncle with 4 articles; articles 1 and 2 reduced, obscure (not illustrated); article 3 with stout seta on inner distal margin; article 4 with inner margin reduced, lacking setae. Flagellum with 5 articles; article 1 triangular with seta on inner distal margin; article 2 with large broom setae on inner margin in proximal third, and smaller broom setae on distal margin; article 3 lacking setae; article 4 with long setae on inner and outer distal margins; article 5 with 5 terminal setae, and 1 subapical seta on outer margin. Squama bearing 2 distal setae.

Labrum (Figure 2I) with pair of hornlike projections distally; setules on basal portion, mid-lateral margin, and just proximal to horns.

Mandibles. Left mandible (Figure 2E) with pars molaris having several spiniform teeth on outer margin; pars incisiva with 4 prominent teeth; lacinia mobilis having 4 (3 prominent and 1 small) teeth with 3 associated palmate, spiniform setae. Right mandible with pars incisiva having 4 to 5 teeth and cluster of spiniform setae. Palp uniarticulate with short setules on outer margin; inner margin lacking setae; 1 large curved “falcate” terminal seta approximately two thirds length of palp.

Labium (Figure 2H). Basal article with numerous setules on inner distal corner and outer margin. Palp with numerous long setules on outer margin; 2 terminal and 1 subterminal stout setae.

Maxillule (Figure 2F). Inner endite with 11 short, stout setae apically and 2 small simple setae subapically. Outer endite with 3 long, curved setulose setae. Palp lacking.

Maxilla. (Figure 2G). Basal region with spinous processes on inner and outer margin; outer endite with 10 comb-like setae; middle endite with 1 trifid, 1 bifid, and 4 simple setae on inner corner along with 4 curved setae; inner endite with row of 13 basally swollen, comb-like setae; and 1 long seta on inner distal margin.

Maxilliped (Figure 3A). Coxae short, wider than long, without setae; basis with palp and inner endite. Palp, article 1 without setae; articles 2–3 with long curved setae on inner margins; article 4 terminating in 4 curved setae. Inner endite (Figure 3A, enlargement) lobate, longer than wide; inner margin with 5 plumose setae; outer margin with 2 coupling hooks, 7 broad apically truncate setae, 1 subapical palmate seta, and 1 truncated seta.

Epignath. Not recovered.

Cheliped (Figure 3B, C). Basis short, widest distally, with sternal margin bearing 2 setae, and 1 seta on

proximal tergal margin. Merus longer than wide, with cluster of 3 setae on distal sternal corner. Carpus short, with sternal lobe bearing 3 setae; tergal margin with row of about 9 setae. Propodus with fixed finger relatively short, distally truncate; sternal margin with 2–4 blunt setae and short inwardly directed spine; distal margin with subterminal dorsal spinous process and terminal cutting edge armed with 5 distal oval pectinate setae; 5 blunt setae on inner margin, and 5 subdistal setae. Dactyl longer than fixed finger, with moniliform tooth at mid-region of cutting edge; 4–5 serrate setae on sternal margin with first located proximal to tooth; outer margin with 3 setae proximal to claw.

Pereopod 1 (Figure 3E) fossorial, approximately twice size of other pereopods. Basis with distal two-thirds of extender margin swollen to form shallow lobe. Ischium short, triangular in shape. Sternal margins of merus, carpus, and propodus bearing 1, 2, 2 large conical spiniform setae, respectively. Merus with 1 long seta on outer margin. Carpus and propodus each with short distal spiniform seta on tergal margin. Dactyl with 2 teeth on proximal sternal margin; outer margin bearing 1 bifid seta (Figure 3E, enlargement). Exopod lacking.

Pereopod 2 (Figure 3F). Basis approximately twice as long as wide, with distal sternal margin bearing 1 long and 1 short seta; proximal tergal margin with small broom seta. Ischium short, with sternal margin bearing single seta. Merus with 4 long setae and 1 spiniform seta on distal sternal margin. Carpus with 2 spiniform setae on sternal margin and several simple setae; distotergal margin with 1 spiniform and 2 long setae. Propodus with broom seta near middle of article, distal margin with 1 long blunt seta and 1 curved spiniform seta; sternal margin with 3 spiniform setae and many setae with attenuated tips. Dactyl longer than propodus, with single hair-like seta on distal margin.

Pereopod 3 (Figure 3G). Basis without broom setae, ischium, as in pereopod 2. Merus with distal sternal margin bearing 5 long setae and 1 spiniform seta. Carpus with distotergal margin bearing 1 simple and 2 spiniform setae; sternal margin with 2 spiniform and several attenuate setae. Propodus with 1 broom seta on distal third of article; distotergal lobe with 2 spiniform setae (1 long and 1 curved); sternal margin with 3 spiniform and several attenuated setae. Dactyl longer than propodus, with distal hair seta as in pereopod 2.

Pereopod 4 (Figure 3H). Basis much longer than wide, with 3 large broom setae on proximotergal margin. Ischium and merus as in pereopod 3. Carpus with 3 sternal spiniform setae and several attenuate setae; outer margin with 2 distal spiniform setae and single long seta.

Propodus with proximal broom seta and 3 comb-like setae on distal tergal margin; sternal margin with 5 spiniform setae. Dactyl subequal to propodus length, with bifid tip.

Pereopod 5 (Figure 3I). Basis as in pereopod 4. Merus, outer margin with 1 long and 1 short seta, with sternal row of 8 simple setae. Carpus with 7 sternal spine setae and several attenuate setae. Propodus, tergal margin with 3 spiniform setae above dactylus; sternal margin with 7 spiniform setae and attenuate setae. Dactyl nearly length of largest tergal propodal spine, shorter than propodus; tip bifid.

Pereopod 6 (Figure 3J). Smaller than other pereopods; merus, carpus, and propodus relatively broad. Basis quadrate, with 1 long simple seta on distosternal margin. Ischium rectangular, with 1 sternal seta. Merus wider than ischium, with medial tergal lobe bearing 2 large broom setae and 1 external seta; sternal margin with 2 long proximal setae and 2 hooked distal setae. Carpus with 1 tergal seta and 5 sternal setae, 2 simple and 3 hooked. Propodus with 10 comb-like setae, decreasing in size from dorsal to ventral margin, 1 flattened spiniform seta above dactylus; sternal margin with 2 large truncate spiniform setae. Dactyl shorter than propodus, with asymmetrically bifurcate tip.

Pleopods (Figure 3K). All 5 pairs similar. Basis with 2 plumose setae on outer margin. Rami with long plumose setae on outer and distal margins.

Uropod (Figure 3M). Peduncle with 1 long and 1 short seta on outer and inner distal margins, respectively. Endopod with 10–12 apparent articles; article 2 longest. Anteromedial margin of articles 1, 2, 5, and 10 with broom setae, last article with 4 terminal setae. Endopod much longer than exopod. Exopod biarticulate; proximal article lacking setae; distal article with 3 terminal setae, middle seta longest, about 1.5 times length of exopod.

Female. Same characters as male except for the form of the sexually dimorphic chelipeds.

Cheliped (Figure 3D). Carpus much longer in female, lacking dorsal setal row and sternal lobe. Fixed finger not strongly developed, appearing as triangular prolongation of propodus (not truncate distally as in male); dorsal margin with row of 6 triangular teeth and row of 7 blunt setae on inner margin; nail with subapical bifurcation. Dactyl without ventral tooth and lacking ventral serrate setae.

Oostegites. On pereopods 1–4, lacking fringing setae.

Manca stages. Pereopods 4 and 5 bearing relatively large 2 articulate exopods.

**Etymology.** The specific name is in honor of the eminent tanaidacean researcher Modest Guțu of the

“Grigore Antipa” National Museum of Natural History, Bucharest, Romania.

**Habitat.** Carbonate sand, sandy clay, clayey sand, sandy mud or sandy gravel substrata in depths ranging from 3–34 meters.

## DISCUSSION

The Caribbean specimens of *Tanapseudes gutui*, n. sp., from Puerto Rico and Tobago appear quite similar to the type species *Tanapseudes ormuzana*. Specific differences distinguishing the new Caribbean species from *T. ormuzana* include: 1) labium with 2 terminal and 1 subterminal spiniform setae, while in *T. ormuzana* only 1 or 2 subterminal setae are present, 2) hornlike projections on the labrum, absent in *T. ormuzana*, 3) propodus of pereopod 1 having a reduced spiniform seta on the upper distal margin near the articulation with the dactylus, while in *T. ormuzana* this seta is well-developed and extending well beyond the first dactylar tooth, 4) pereonites 3–6 with anterior margins rounded, while in *T. ormuzana* they are produced, and 5) lateral margin of pleotelson entire and gently rounded, not having a subacute lateral lobe as in *T. ormuzana*.

In the fully developed male of *T. gutui*, the dactyl of the cheliped is armed with a translucent subacute tooth midway on the cutting edge along with a shallow trilobed carpal process (Figures 3B, C). Although these characters were not evident in the limited number of *T. ormuzana* males examined during our study, their absence may reflect a stage of development rather than a reliable taxonomic character.

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First Record and Habitat Notes for the Genus *Lightiella* (Crustacea, Cephalocarida, Hutchinsoniellidae) from the British Virgin Islands

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# FIRST RECORD AND HABITAT NOTES FOR THE GENUS *LIGHTIELLA* (CRUSTACEA, CEPHALOCARIDA, HUTCHINSONIELLIDAE) FROM THE BRITISH VIRGIN ISLANDS

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## INTRODUCTION

The crustacean class Cephalocarida, as currently understood, is composed of five genera and ten species (Hessler and Elofsson 1996, Hessler and Wakabara 2000). Although in some instances numerous specimens have been collected in a single locale (e.g., the nearly 120 specimens of *Lightiella incisa* Gooding, 1963 from Puerto Rico studied by Sanders and Hessler (1964), and the numerous specimens of *Hutchinsoniella macracantha* Sanders, 1955 now known from Buzzards Bay, Massachusetts, see Hessler and Sanders 1973:193), most reports are based on very few specimens. For example, the original description of the genus *Hutchinsoniella* Sanders, 1955 was based on only eight specimens from Long Island Sound, New York (Sanders 1955); the genus *Sandersiella* was originally described by Shiino (1965) on the basis of only one specimen from Japan; the genus *Chiltoniella* Knox and Fenwick, 1977 was based on two specimens from New Zealand (Knox and Fenwick 1977), and the genus *Lightiella* Jones, 1961 was based on seven specimens from San Francisco Bay (Jones 1961). *Lightiella moniotae* was described for a single individual from New Caledonia (Cals and Delamare-Deboutteville 1970); *Sandersiella calmani* for two specimens from Peru (Hessler and Sanders 1973); and *Sandersiella bathyalis* for two specimens from the deep ocean off southwest Africa (Hessler and Sanders 1973). The single eastern Caribbean record (Barbados) of a cephalocarid also was based on two specimens (Gooding 1963), although Gooding also discussed two specimens from Puerto Rico in that account.

Cephalocarids are of such interest morphologically and phylogenetically, and are found so infrequently, that their presence anywhere is noteworthy. As part of an ongoing survey of the cryptic marine invertebrates of certain Caribbean islands, we obtained a single specimen of a cephalocarid from Guana Island, British Virgin Islands, that matches most closely the description by

Gooding (1963) of *L. incisa*. The find is of interest not only because it is the first record for the far eastern Caribbean other than Gooding's (1963) two type specimens from Barbados, but also because of the unusual habitat in which it was found.

There are three additional records of cephalocarids in the Caribbean other than Gooding's (1963) original description of *L. incisa* from Barbados and southwestern Puerto Rico. Sanders and Hessler (1964) reported *L. incisa* from the Puerto Rican site. This same species also is known from the Yucatan Peninsula (De Troch et al. 2000) and Carrie Bow Cay, Belize (Schiemer and Ott 2001).

Several records of cephalocarids are known for waters just outside the Caribbean. Wakabara (1970) recorded *Hutchinsoniella* from Brazilian waters, and the genus *Sandersiella* was also reported from Brazil by Wakabara and Mizoguchi (1976). The latter record was corrected by Hessler and Wakabara (2000), who described the species in question as new, making it the type of their newly erected genus *Hampsonellus*. There are several reports of *Lightiella* from the east and west coasts of Florida (Hessler and Sanders 1973, McLaughlin 1976, Saloman 1978, Stoner 1981) and a single record from the coast of Alabama (Heard and Goeke 1982).

## MATERIALS AND METHODS

The single specimen was collected during a biodiversity survey of the cryptic marine invertebrates of Guana Island, British Virgin Islands (18°28'33"N, 64°34'29"W), led by T.L. Zimmerman and J.W. Martin. Various collecting methods were employed during that survey, including light traps, hand collecting, yabby pumps, and arrays of artificial reef matrices (ARMs). The cephalocarid was found by sorting through a collection of sand (a mixture of siliceous and calcium carbonate) and gravel collected by hand using SCUBA on July 8, 2001. The sand and gravel were from an area of large

boulders among scattered coral heads, sponges, and soft corals at a depth of approximately 5 m immediately south of Long Point, Muskmellon Bay, Guana Island (2001: Station 12 of the Zimmerman and Martin survey, individual specimen number Vd 0054). Observations and illustrations of the preserved specimen were made with a Wild M5APO dissecting stereoscope and a Nikon Labophot, both with drawing tubes. The specimen has been catalogued in the Crustacea collection of the Natural History Museum of Los Angeles County as LACM CR 2001-005.1.

### DESCRIPTION

The single specimen (Figure 1) measures 2.1 mm from the tip of the cephalic shield to the tip of the telson. The body (Figure 1A, B) consists of a cephalic shield followed by 9 thoracic and 12 post-thoracic somites including the telson; the first thoracic somite is covered to some extent by the cephalic shield, possibly an artifact of preservation. All of the post-thoracic somites except the telson bear acute lateral spines, increasing in size toward the posterior somites. The telson bears a ventral comb row of spine-like teeth across its full width (Figure 1D); no other somites bear such a row. The dorsal medial surface of the telson (Figure 1C) is extended posteriorly as a pair of triangular teeth that project beyond the posterior margin of the ventral comb row. The caudal rami are relatively short and thick, and each is shorter than the combined length of the last abdominal segment and the telson. The tip of each ramus is strongly indented, with an acute medial spine-like tooth and a shorter and less acute lateral tooth. Each ramus bears one long and two short setae (one of the short setae is broken on the left side); a much longer seta on each ramus was present in life but has been broken and is not figured. The single egg is attached to the tip of the modified 8th limb on the ventral surface of the animal's right side. In dorsal view (Figure 1A), the egg protrudes to the right of the body; in ventral view (Figure 1B) it appears directed slightly to the posterior.

### REMARKS

Characters visible to us without dissection are in general agreement with those described for *L. incisa* by Gooding (1963) and Sanders and Hessler (1964). In particular, the low number of thoracic limbs (7 total, excluding the modified egg-bearing limb), the relatively short and stout caudal rami, the single comb row on the ventral border of the telson, and the single extruded egg

are together indicative of the genus *Lightiella* and serve to separate members of this genus from other cephalocarids (e.g., see Hessler and Sanders 1973, McLaughlin 1976, Hessler et al. 1995). Mouthpart morphology was not examined because of our reluctance to dissect the single specimen.

Hessler et al. (1995) noted that the large extruded egg of *H. macracantha* is "cemented to the knob which forms the tip of the small ninth thoracic limb." The situation is similar in *Lightiella*, except that a single egg is attached to what appears to be a modified "eighth" limb (which is located on the ninth thoracic segment but is numerically the eighth because of the missing thoracopod in *Lightiella*; see Sanders and Hessler 1964). Sanders and Hessler (1964) examined 17 ovigerous adults of *L. incisa*, and 16 of them carried a single egg sac (the other individual carried paired egg sacs as in *Hutchinsoniella*). Although to our knowledge the present paper contains the first illustrations of the extruded egg of *L. incisa*, its occurrence has been noted previously (Gooding 1963, Hessler and Sanders 1964, De Troch et al. 2000). Hessler et al. (1995: Figure 1) illustrated the paired egg sacs in *H. macracantha*.

### Notes on Movement

The specimen was sorted from the sample while it was still alive. In fact, what brought the small animal to our attention, and distinguished it from the surrounding copepods that it resembled, was its movement pattern. The animal moved in a very graceful and smooth way reminiscent of a branchiopod notostracan. It would often make very tight reversals upon itself when changing direction. This type of movement was noted also by Sanders (1963:9–13, Figures 12, 13) in his classic work on functional morphology and anatomy of *H. macracantha*.

### Habitat Notes

The habitat is of interest because it is atypical for cephalocarids. Station/Sample 12, 2001, of the Zimmerman and Martin survey is an apparently well oxygenated shallow (5–10 cm) layer of sand and pea gravel overlying a more or less solid rock base at the bottom of a fissure (1–2 m wide at the base) in the bedrock that slopes away from the base of the island. The fissure runs perpendicular to the shore and slopes slightly upward; the depth where the sand and gravel were collected was approximately 5 m. This was in an area characterized by large boulders calved from the cliff face above. At the base of the boulder field, at a depth of about 7 m, the bottom consisted of coarse gravel, sand, and

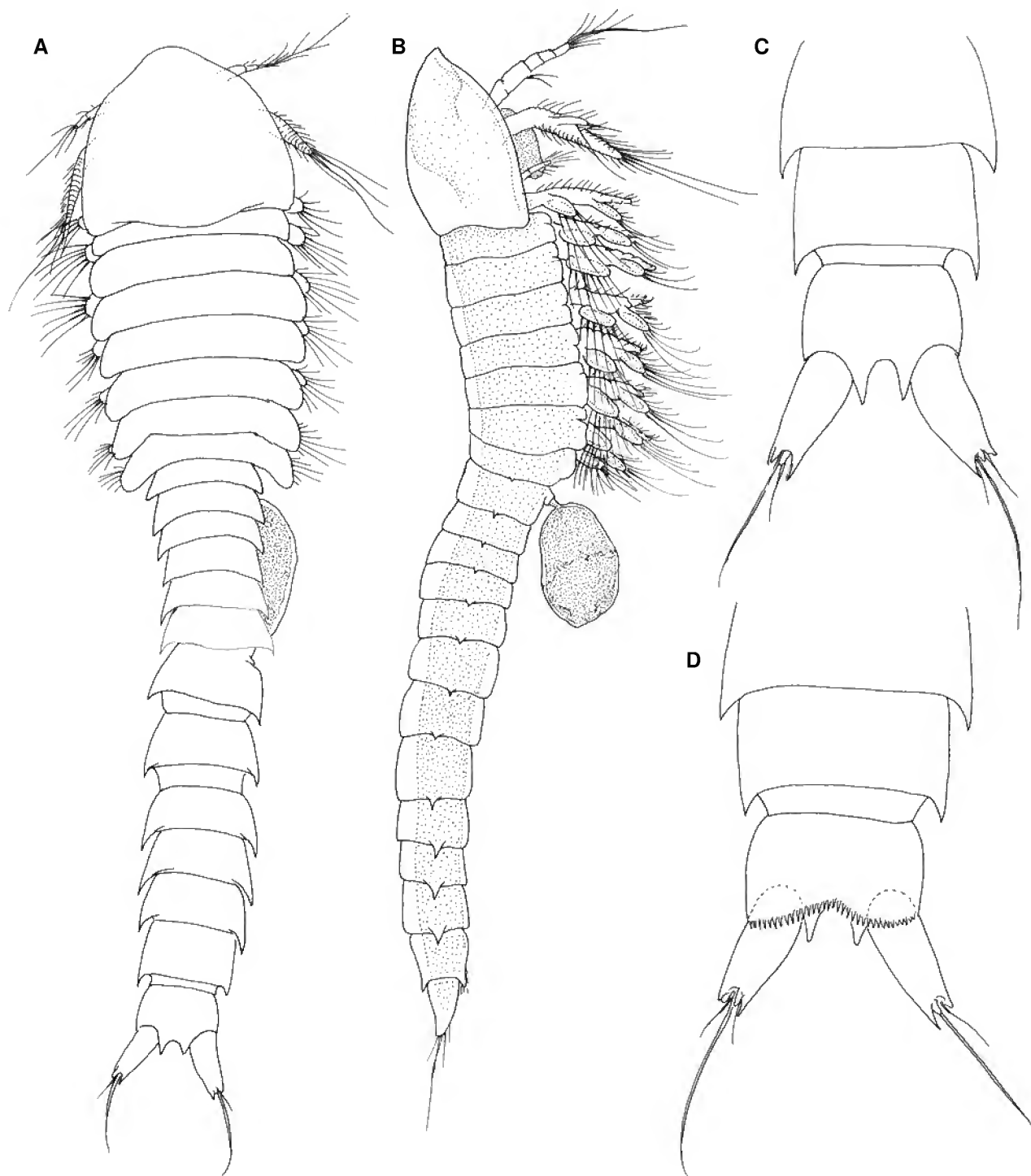


Figure 1. *Lightiella incisa* Gooding, 2.1 mm specimen from Long Point, Guana Island, British Virgin Islands, Caribbean (LACM CR 2001-005.1). A, entire animal, dorsal view. B, same, lateral view. C, posterior two somites, telson, and caudal rami, dorsal view. D, same, ventral view showing comb row of spine-like teeth on posteroventral border of telson.

cobble with scattered small coral heads, sponges, and soft corals. Further seaward the coral heads coalesce into reef. The bottom sediment is often covered with a thin layer of fine calcareous algae and flocculent matter, although this material was less prevalent in 2001 than in the two previous years of our survey. Other organisms sorted from the sand and gravel in the rock fissure (Station 12) included lancelets, polychaete worms, molluscs (chitons, bivalves, and gastropods), pycnogonids, and varied crustaceans (amphipods [including some that appear to be ingolfiellids], decapods, tanaidaceans, and ostracods).

Gooding's (1963) original four specimens of *L. incisa* (two from Barbados and two from Puerto Rico) were all from flocculent sediment within a *Thalassia* grass bed; three of the four were aspirated from decapod burrows. Similarly, De Troch et al. (2000) found large numbers of specimens "between the roots of sea grasses." Hessler and Sanders (1973:195) noted that "the single common feature of all cephalocarid habitats is the flocculent nature of the superficial sediment to which these animals are intimately bound by their basic mode of life." Schiemer and Ott (2001) recently shed additional light on the microhabitat of *L. incisa*, documenting its occurrence only below the redox potential discontinuity layer and with a maximum density at 12–15 cm below the surface at a shallow sand bar on Carrie Bow Cay, Belize. Schiemer and Ott (2001) suggested that *L. incisa* inhabits "oxygen-rich microzones" in deeper sediments. This was also suggested by De Troch et al. (2000), in their study of *L. incisa* from the Yucatan Peninsula. De Troch et al. (2000) concluded that *L. incisa* was "an endobenthic species occupying anoxic sediments oxygenated by bioturbation (e.g., Polychaeta) rather than being an animal living in the oxygenated top layers." Thus, its occurrence in anoxic flocculent sediments may be tied to the occurrence in these same sediments of polychaete worms or other burrowing organisms that provide limited oxygenation via their burrowing and ventilatory activities. Although we found our specimen among sand and gravel, it is possible that the gravel acts in a manner similar to turtle grass beds as a "sediment trap," collecting the flocculent material that in turn supports cephalocarids (see Sanders and Hessler 1964).

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